# HYDROGEOLOGICAL INVESTIGATION
# FOR THE HAMLET OF KILBRIDE
# REGIONAL MUNICIPALITY OF HALTON
# PROJECT NO. PR-597

Draft #2

HYDROLOGY CONSULTANTS LIMITED

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Our File No. 8839

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Presentation - September 16, 1982
Kilbride Settlement Area Secondary Plan
Comments of Donald May, M.C.I.P.
On behalf of Kilbride Holdings

## INTRODUCTION

All recent Official Plans have stressed the need to restrict scattered rural development in favor of allowing limited growth in the hamlets. Official Plan Amendment 81 set out broad objectives for the growth of Kilbride. Lot sizes were established at a minimum of one acre subject to soil and water conditions. This secondary plan is required as a result of the recent Regional and Niagara Escarpment Official Plans.

Upon review, this secondary plan seems to concentrate on the soil and potable water conditions and is predicting that the development potential of Kilbride is now approximately 80 additional units.

## CONCERNS

a) Width of McNiven Road - Now that development has been dramatically reduced, McNiven Road should be developed as a local street and not encouraged for through traffic. Lots should be encouraged to front on McNiven and the road allowance should be changed from 26 metres to 20 metres (66 feet) (page 44).

b) Minimum Lot Size - Since further detailed hydrogeological investigation is required on each site, the figures on page 49 and the fourth paragraph on page 48 should refer to the lot sizes as approximate. This recommendation is to avoid an unnecessary official plan amendment for a lot that does satisfy the hydrogeological criteria, but may be slightly less than the recommended size.

c) Recharge Area Surrounding Existing Residences - The Secondary Plan is unclear as to the development of this area. We would recommend an additional sentence, to paragraph four of page 48, to permit development adjacent to existing homes provided their services are protected.

d) Existing water and Sewer Problems - The Plan should provide for an educational system to advise existing residents as to improvements that could be made to better their systems.

e) Timing - This secondary plan envisions a further amendment to Official Plan Amendment 81. Development applications that comply with Amendment 81 and this secondary plan, (including an approved hydrogeological study), should not have to await this further amendment. A further delay of two to three years is not reasonable, when rural people have been directed to the Hamlets for the past 10 years as an alternative to rural severances. Planning should be accountable to the needs of the community.

SUMMARY

This is an excellent document which analyses the hydrogeological issues in detail. Other than clarification and some minor flexibility, our only requested change is to encourage McNiven Road to be a local street.

We do recommend the Plan provide for assistance to existing residents now that all this information is available.

The City of Burlington should encourage development to proceed immediately provided the subdivisions meet the requirements of Amendment 81 and this Secondary Plan (once approved by the Region).

Respectfully Submitted
on behalf of Kilbride Holdings Ltd.

Donald F. May, M.C.I.P.
MAY, PIRIE & ASSOCIATES LIMITED

HYDROGEOLOGICAL INVESTIGATION
FOR THE HAMLET OF KILBRIDE
REGIONAL MUNICIPALITY OF HALTON
PROJECT NO. PR-597

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HYDROGEOLOGICAL INVESTIGATION
FOR THE HAMLET OF KILBRIDE
REGIONAL MUNICIPALITY OF HALTON
PROJECT NO. PR-597

# 1.0 INTRODUCTION

To assist in determining the potential development at the Hamlet of Kilbride, a hydrogeologic investigation was authorized by the Regional Municipality of Halton.

The objectives of the investigation were to evaluate the availability and quality of groundwater supplies from the local aquifers; the probable and recommended yields of individual wells; the impact of groundwater withdrawals and septic-system effluent discharge of any new development on the groundwater systems and the existing community; the possible phasing of such developments to minimize adverse effects; and the determination of testing requirements to support the study findings.

## 2.0 SUMMARY AND CONCLUSIONS

1) Three aquifer systems have been defined in the Kilbride study area, being the dolomite bedrock aquifer in the northwesterly area, an outwash sand and gravel aquifer throughout the remaining study area, and an underlying shale bedrock aquifer.

Where possible, wells are completed in either the dolomite and overburden aquifers, which exhibit the capability of supplying groundwater in excess of 30 litres/minute (6.5 gpm). The shale bedrock provides significantly less water to individual wells, averaging about 7 litres/minute (1.5 gpm). None of the defined aquifers exhibits the potential of sustaining a communal well within the study area.

2) To supply a single-family residence through each of the two daily peak-demand periods, a water supply of about 0.7 cubic metres/hour (150 gph) should be available from the combined well yield and the system storage capacity. Coupled with the largest commonly available precharged pressure tank (0.1 cubic metres useable storage), a well with a yield of about 9 litres/minute (2 gpm) would be sufficient to meet the peak demand. Generally, wells terminating in the dolomite and overburden are generally adequate sources, whereas additional storage or modified water-use may be required for water systems supplied by shale wells. The low-yield potential of the shale bedrock is responsible for the quantity problems reported for the immediate Kilbride area.

3) The chemical quality of groundwater from wells completed in the overburden, the dolomite, and the shale at shallow depth below the contact with the overlying formation should be suitable for domestic purposes without treatment, throughout the Kilbride area. Mineralized water, containing excessive chloride and/or hydrogen sulphide, is obtained from the deeper shale bedrock.

4) The local topography strongly controls the direction of groundwater movement within the overburden and the shallow bedrock formations. Groundwater recharge throughout much of the Kilbride area essentially comprises the precipitation locally infiltrating the surficial sediments. Significant lateral groundwater inflow to the area is not evident from the developed groundwater flow systems.

5) Regional basin studies indicate that the groundwater contribution, or recharge to the aquifer systems, may be about 3.5 $m^3$/day/hectare (0.2 mgd/square mile) within the Kilbride area. Recognizing the distribution of surficial sediments, it is estimated that the infiltration may be about 2.6 $m^3$/day/hectare (0.15 mgd/square mile) in the till areas and about 4.0 $m^3$/day/hectares (0.23 mgd/square mile) within the granular areas. These infiltration values correspond reasonably well with those obtained by similar Ministry of the Environment investigations.

6) The daily water requirement for domestic supply and sewage dilution at a residential dwelling is estimated to be about 3.1 cubic metres (700 gallons). To sustain this demand, a sufficient capture area must be provided for each dwelling by consideration of the anticipated recharge rate. Consequently, individual lots should be 1.2 hectares (3 acres) within the till areas and 0.8 hectares (2 acres) within the sand areas to ensure a dependable and potable water-supply on a perennial basis.

7) The Kilbride study area may be subdivided into three distinct sub-areas according to the prevailing hydrogeological conditions.

In the northwest, the area is underlain by dolomite bedrock, covered by a thin veneer of granular till and outwash sediments. The bedrock is the major aquifer and commonly yields adequate domestic supplies. This aquifer is susceptible to possible pollution from septic-system effluent and detailed testing will be required in the placement of septic-tile beds and of water-supply wells to minimize this hazard. Surficial sediments largely comprise granular sediments, with good infiltration capacity and lot areas of 0.8 hectares (2 acres) should be adequate to sustain the water demand.

In the northeast, the area is underlain by moderately thick drift, overlying the shale bedrock. Typically, where the overburden thickness exceeds 10 metres (30 feet), adequate domestic supplies are obtained from the basal granular aquifer. Where the overburden is thin or fine grained, marginal supplies are provided by drilled wells extended into the shale bedrock. Much of the present Kilbride community is situated within an area where supplies are largely obtained from the shale bedrock. The area is largely underlain by silt till with a low to moderate infiltration capacity, and present recharge information indicates that lot areas may be 1.2 hectares (3 acres) in size.

In the southern area, the overburden largely comprises a terrace deposit of granular sediments, generally exceeding 20 metres (60 feet) in thickness, and is underlain by the shale bedrock. Surficial sediments have a good infiltration capacity and lot areas may be about 0.8 hectares (2 acres).

Due to the proximity of Twelve Mile and Bronte Creeks and the extensive mining operations, the water-table is locally depressed, with the result that water wells commonly extend into the shale bedrock. Sanitary protection of the water-yielding zones is assured by the thick overburden sequence; however, water-well yields may be minimal for domestic use.

Additional development within the existing Kilbride community is not supported by the evaluation of groundwater availability, and, deterioration of the chemical water quality may eventually occur if actual water consumption approaches the calculated requirement.

8) Beneath the three defined areas, capable of accommodating new development adjacent to Kilbride, groundwater movement is generally in a direction away from the hamlet, and residential development is unlikely to have an impact on the quantity and quality of groundwater available to the existing wells.

Phasing of development is not required within these areas being independent of each other and the Kilbride Community. The preferred order of development based on the water-supply and septic-system requirements would be the northeast area, the northwest area, and the southern area.

9) Field testing is required to confirm the local hydrogeologic conditions. This testing may be conducted by the developer at the time of draft subdivision approval, and must be sufficient to establish the aquifer and well yields; the direction of groundwater movement and the impact on the existing groundwater sources. Should establishment of these conditions be required for the Kilbride study area

prior to development, testing would be required in the northeast and northwest areas and would involve the installation of small-diameter piezometers, or piezometer nests, at eight locations in each area; the conductance of hydraulic tests; the mechanical analyses of overburden samples, and short-term monitoring of the groundwater levels.

## 3.0 ACKNOWLEDGEMENTS

The co-operation and comments received from staff of the Regional Municipality of Halton and the City of Burlington were appreciated during the preparation and review of this report, and, in particular, the assistance provided by Mr. R.F. Mac Millan, Mr. F. Crann, Mr. G. Sullivan, and Mr. L. Siddiqui.

# 4.0 HYDROGEOLOGIC CONDITIONS

## 4.1 GENERAL

The groundwater conditions in the Kilbride area were essentially determined from a compilation of the water-well data on file with the Ontario Ministry of the Environment[1].

About 200 well records were available for the map area, shown on Map 1, which encompasses the defined Kilbride study area, to assess the adjacent physical conditions. Of these, 87 wells were selected, based on the reported well data and locations, and the apparent reliability of the recorded information, to represent the prevailing hydrogeologic regime. Summaries of the well reports are listed in Appendix A in Imperial units as available in the Ministry files. Subsequent analyses involved conversion to the metric scale, and the following report, maps and figures are provided in this scale.

The well data were supplemented by information available in geologic and hydrologic publications of various government agencies [2,3,4] and local reports of consulting engineering firms [5,6], as listed in the Bibliography, Appendix B.

To visualize the nature and distribution of the sub-surface formations at Kilbride, four vertical sections were prepared, shown on Figures 1 and 2, essentially paralleling the principal concession and side roads within the hamlet.

These sections show that Kilbride is situated within a geologically complex setting, along the buried crest of the Niagara Escarpment.

Significantly, the upland area adjacent to Bronte Creek is not attributable to the escarpment, which is defined by the dolomite formation that forms the caprock, but rather to an extensive overburden "plug", largely comprising granular outwash sediments. The configuration and extent of this thick overburden deposit in the south and southeast study areas are exemplified in Sections B-B and D-D.

Elsewhere at Kilbride, particularly where the dolomite bedrock subcrops, the overburden sequence is appreciably thinner.

The dolomite formation bottoms at an elevation of about 250 to 253 metres ASL (820 to 830 feet ASL), within the Kilbride area, and is absent where the erosion of the bedrock surface occurred to a lower elevation, as at the excarpment area.

The main water-bearing zones are also evident from the sections, being the dolomite bedrock, the shale bedrock and the overburden. Characteristically, wells are completed in the dolomite bedrock or the overburden, where possible, rather than in the underlying shale bedrock.

## 4.2 GEOLOGY

### 4.2.1 Bedrock

The formations occurring beneath the Kilbride area comprise rocks of Silurian age, being a sequence of red, green and gray shale of the Cataract Group, overlain by gray dolomite of the Amabel Group[2].

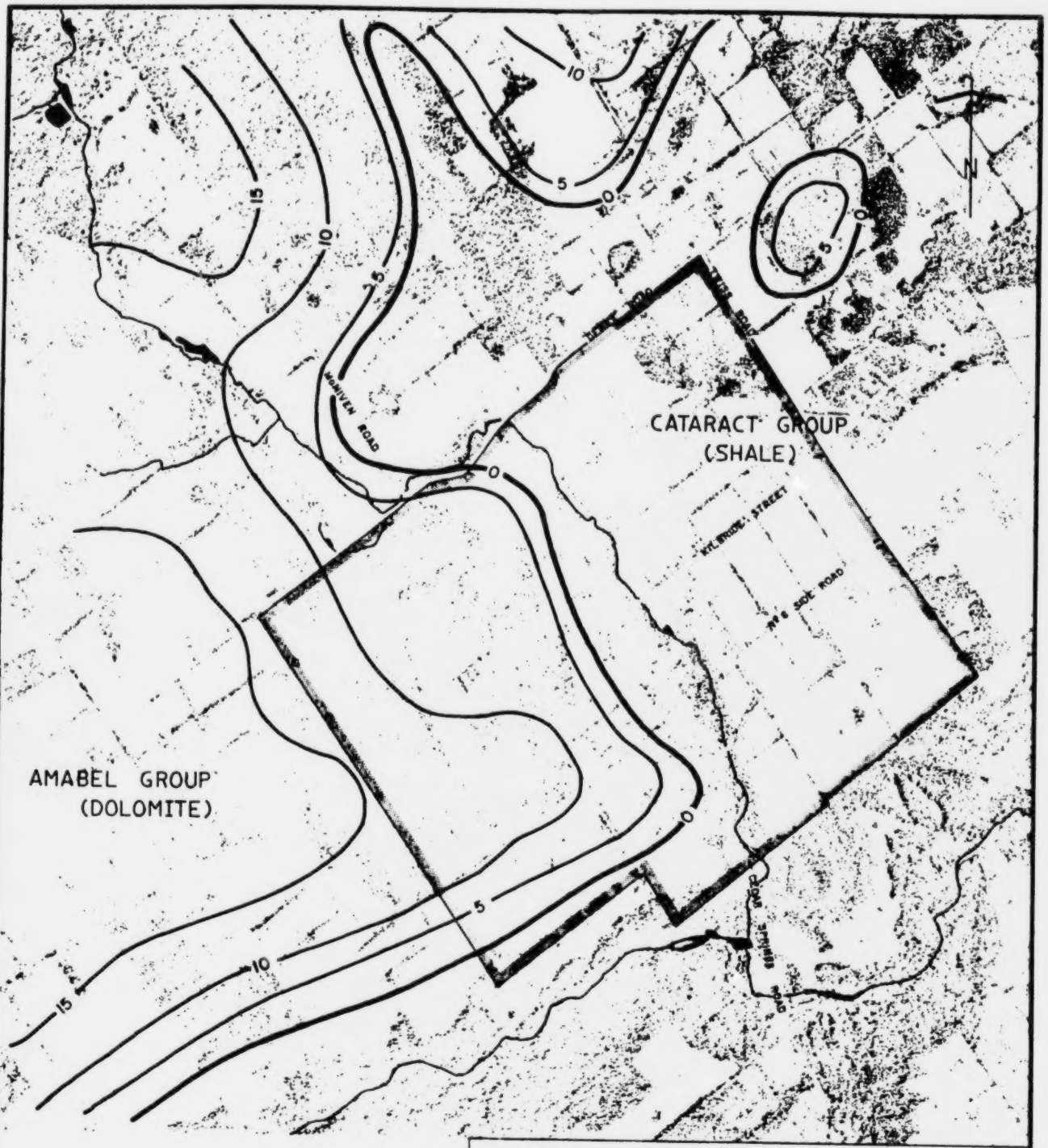
The distribution of these formations is shown on Figure 3, which also illustrates the thickness of the dolomite bedrock as reported in the well logs. Significantly, in the specific study area, the dolomite bedrock is entirely absent east of the creek and gradually thickens in the westerly direction to about 12 metres (40 feet). The underlying shale formation is partially penetrated by local wells and from regional information is deduced to have a full thickness of about 30 metres (100 feet).

The bedrock formations are largely covered with glacial drift. Larger outcroppings are plotted in Figure 4, which shows the topography of the bedrock surface. The outcroppings shown at an elevation higher than 250 metres ASL (830 feet ASL) comprise dolomite, whereas the outcropping occurring within the stream valley downgradient from the hamlet comprises shale. A major depression is evident within the bedrock surface extending through Kilbride towards the Bronte Creek, and is the probable location of a preglacial tributary, with an orientation similar to the present-day stream.

4.2.2 Overburden

The general distribution of the surficial sediments at Kilbride is shown on Figure 5, and has been largely derived from the previous Pleistocene Geology study[3], with local modifications as determined by detailed soils and air-photo interpretation studies[5,6].

The deposition and distribution of the overburden sediments within Kilbride were largely controlled by the bedrock topography, as shown in Figure 4. During the period of glaciation, the main bedrock depressions served as

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KILBRIDE HYDROGEOLOGIC INVESTIGATION

# DOLOMITE THICKNESS

HYDROLOGY CONSULTANTS LIMITED
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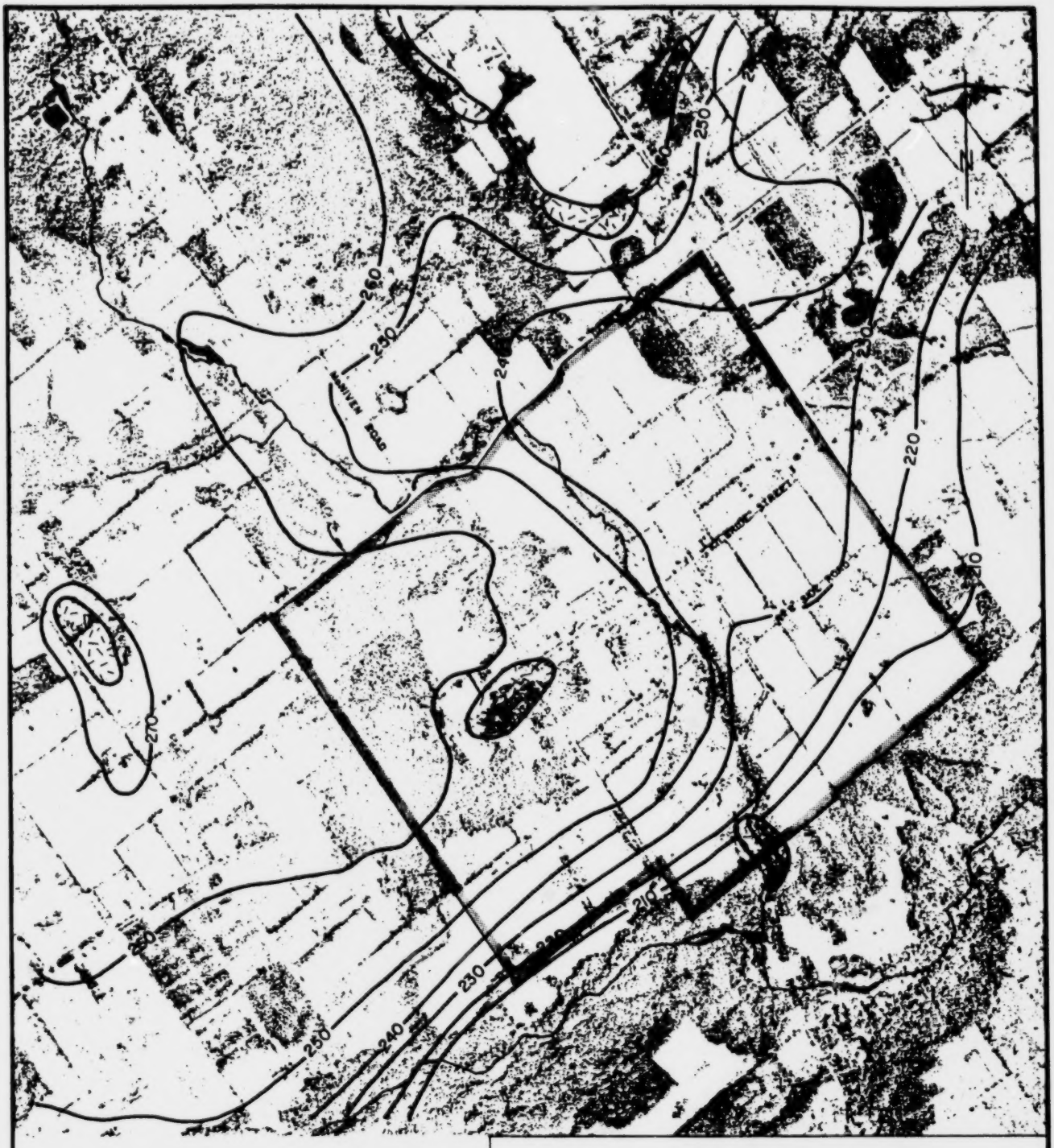
| | | | |
|---|---|---|---|
| Job N° | 8839 | Scale | 1:20,000 |
| Drwn. by | JFS | Date | OCTOBER, 1980 |
| Appr. by | LGB | | |
| Revised | | | |

FIGURE 3




STUDY AREA

BEDROCK OUTCROP

BEDROCK SURFACE CONTOUR
– in METRES Above Sea Level

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# BEDROCK TOPOGRAPHY

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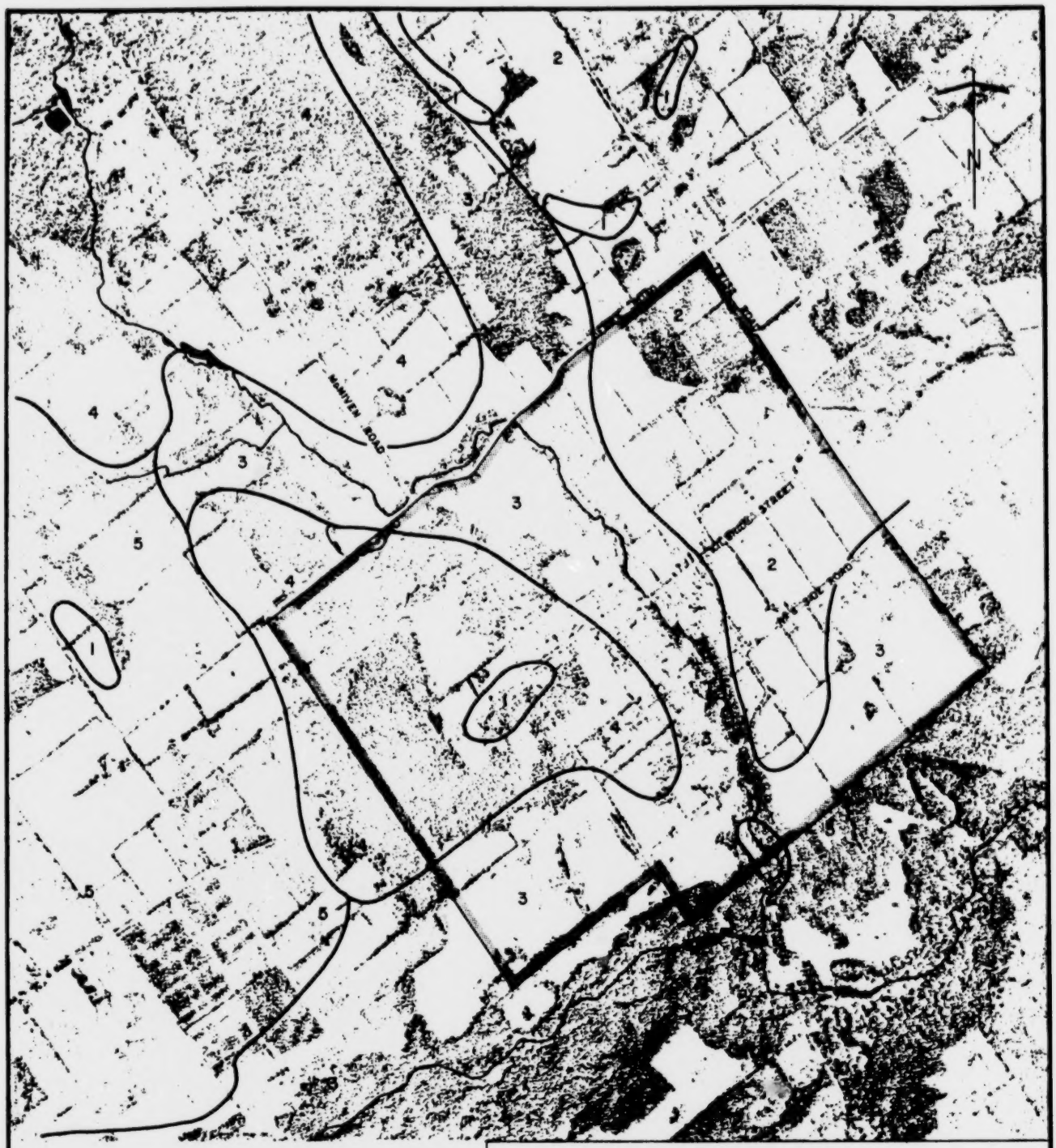
| Revised | | | |

FIGURE 4




STUDY AREA

1 DOLOMITE/SHALE BEDROCK

2 SILT TILL (HALTON FORMATION)

3 OUTWASH GRAVEL

4 OUTWASH COMPLEX — BOULDERY TILL, SAND, AND BEDROCK RIDGES

5 SAND, MAINLY SHALLOW-WATER LACUSTRINE

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# SURFICIAL GEOLOGY

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| | | | |
|---|---|---|---|
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| Appr. by | LGB | | |
| Revised | | FIGURE | 5 |

spillways for fluvial meltwaters when the ice-front was situated adjacent to the escarpment, resulting in the placement of thick, outwash and ice-contact deposits within the depressions. Over-riding of the Kilbride area occurred during the last major ice advance, depositing a thin mantle of sandy and silty till over much of the granular sediments. Subsequently, deep erosion has locally exposed the granular deposits along Bronte Creek and its principal tributaries.

Figure 6 shows the thickness of the overburden sediments at Kilbride and the influence of the bedrock topography. The thickest sediments commonly exceed 20 metres (65 feet) and occur beneath Twelve Mile Creek, attaining a known maximum of about 43 metres (140 feet) in the terrace area south of the hamlet and adjacent to Bronte Creek.

The geologic logs suggest that the outwash and ice-contact sediments extend to the bedrock surface, but have a variable composition ranging in size from clay to gravel which is consistent with the nature of deposition.

The surficial till, where present, may have low-permeability and may locally extend to a depth of several metres as evidenced by testing in the easterly study area[6].

## 4.3 GROUNDWATER MOVEMENT

The reported static levels of the wells completed in the overburden and in the bedrock were plotted to determine the groundwater movement within the main aquifer systems. Together with information on the formation distributions and the surface topography, contour maps were prepared to determine the direction of groundwater movement, the extent of the local aquifer systems, and the recharge-discharge characteristics.

STUDY AREA

LINE OF EQUAL OVERBURDEN THICKNESS (ISOPACH) - in METRES

REGIONAL MUNICIPALITY OF HALTON
KILBRIDE HYDROGEOLOGIC INVESTIGATION

# OVERBURDEN THICKNESS

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| | | | |
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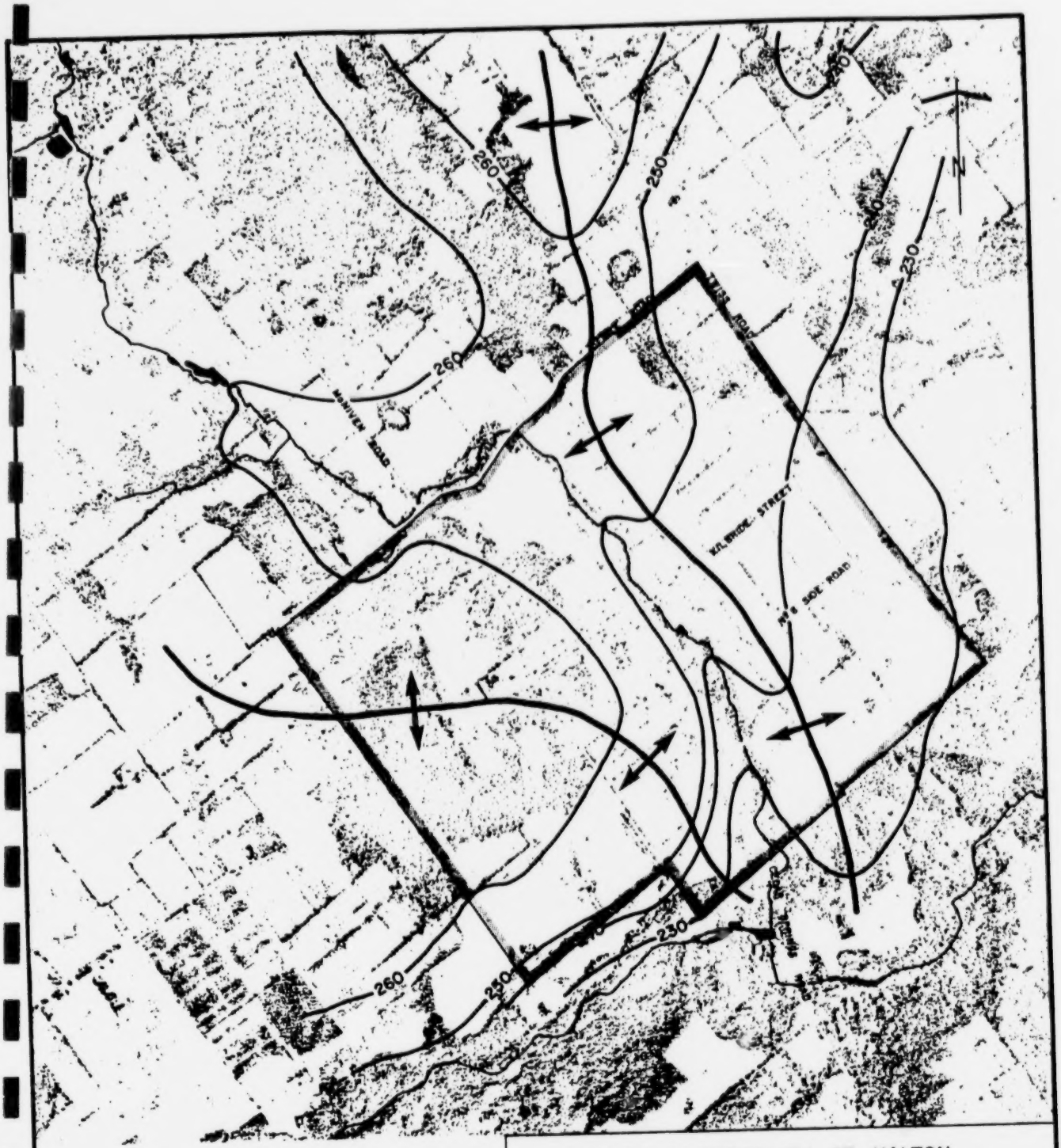
| Revised | | FIGURE | 6 |

Figures 7 and 8 are groundwater-level contour maps for the bedrock and the overburden, respectively. These contours are lines of equal hydraulic potential within the formations, and indicate the direction of groundwater movement, being at right angles to the contour lines from areas of high potential to low potential.

Typically, the groundwater contour map is a subdued expression of the surface topography. This is evident by the configurations of both the overburden and bedrock contour maps, which show that the local topography has a considerable influence on the groundwater flow pattern.

The similarity in the groundwater maps for the overburden and bedrock further indicates good hydraulic connection between these aquifers, as would be expected considering that the developed overburden and bedrock aquifers are frequently in contact with each other.

Having determined the configuration of the groundwater levels, it is then possible to locate the groundwater divides, and, thus, the contributing recharge areas adjacent to the receiving water courses. The principal groundwater divides developed for the bedrock and overburden systems are shown on the contour maps to closely border the existing Kilbride development, leading to the critical finding that the recharge to the groundwater systems is derived from infiltrating precipitation in a rather limited area, and that lateral groundwater flow through the aquifers is insignificant.




STUDY AREA

WATER LEVEL CONTOUR
(In METRES Above Sea Level)

GROUNDWATER DIVIDE

REGIONAL MUNICIPALITY OF HALTON
KILBRIDE HYDROGEOLOGIC INVESTIGATION

## WATER-LEVEL CONTOURS IN THE OVERBURDEN

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FIGURE 7

## 4.4 GROUNDWATER RECHARGE

The amount of infiltrating precipitation recharging the aquifer systems may be estimated from hydrometric records by the Wundt method[7], which is based on an analysis of monthly minimum streamflows. This method has been found acceptable by Ministry of the Environment staff in estimating the total groundwater contribution in recent basin studies.

Analysis conducted by the Ministry of the Environment in the adjacent Oakville Creek drainage basin[8,9], for a small sub-basin (02 HB 204) in a similar geologic setting to the Kilbride area indicated that the groundwater contribution averaged about 125 mm (5 inches) annually, which is equivalent to an areal recharge of about 3.5 $m^3$/day/hectares (0.2 mgd/square mile), for the six-year analysis period; varying from about 88 mm (3.5 inches) to 175 mm (7 inches) for individual water years. A groundwater contribution of the same magnitude would be anticipated in the Kilbride area.

A similar analysis conducted using the historical streamflow data[10] for the nearest monitored station, located on Bronte Creek (02 HB 011), yielded similar results for the groundwater contribution, being about 125 mm annually or 3.5 cu m/day/hectare.

The nature and distribution of the surficial materials has a significant impact on the infiltration, as it is readily apparent that gravel may infiltrate significantly larger quantities of water than clay. The distribution of materials within the Kilbride basin is about 35 percent till and 65 percent granular sediments and bedrock. A balance between the anticipated infiltration of these materials, and, correspondingly, the recharge to the aquifers in view of their

shallow placement, and the deduced groundwater runoff may be effected by applying infiltrations of 2.6 $m^3$/day/hectare (230 gpd/acre) to the till deposit and 4.0 $m^3$/day/hectare (320 gpd/acre) to the granular sediments and bedrock. Considering that the thin overburden is largely granular and that the bedrock is fractured, it appears reasonable to apply a fairly high infiltration rate to the bedrock and/or thin drift areas. Discussions with Ministry of the Environment personnel[12] indicated that hydrograph-separation studies of the Grand River basin yielded similar results, of 1.7 to 2.6 $m^3$/day/hectare (0.1 to 0.15 mgd/square mile) in the till areas and 3.5 to 5.0 $m^3$/day/hectare (0.2 to 0.3 mgd/square mile) in the sand plain areas.

## 4.5 WELL YIELDS

As previously discussed, three aquifer systems are developed by wells at Kilbride, dependent on the local hydrogeologic conditions, these being the Amabel dolomite, the Cataract shale and the overburden.

### 4.5.1 Amabel Dolomite

Domestic drilled wells commonly penetrate the full dolomite sequence and obtain water from a heterogeneous network of fracture and bedding planes. The following table lists the yield and capacity information for the 30 selected dolomite wells.

| | |
|---|---|
| Yield Range (1/min) | 9 - 135 |
| Mean Yield (1/min) | 32 |
| Specific Capacity Range (1/min/metre) | 1.5 - 105 |
| Mean Specific Capacity (1/min/metre) | 4.5 |

| | |
|---|---|
| Available Drawdown Range (metres) | 2 - 11.5 |
| Mean Available Drawdown (metres) | 6.1 |
| Percentage of Wells Yielding less than 14 l/min (3 gpm) | 23 |

A comparison of the mean drawdown and specific-capacity values indicates that the reported mean yield is the maximum available from the aquifer. The apparent transmissivity is low, possibly being about 7 $m^3$/day/metre (500 gpd/foot).

The lower-yield wells occur along the escarpment front due to the limited saturated thickness, and more abundant domestic supplies are obtained in the westerly study area.

4.5.2 Cataract Shale

The shale bedrock is largely developed in the easterly two-thirds of the study area where the dolomite is absent or where the overburden is either fine-grained or thin and incapable of sustaining domestic withdrawals. The largest concentration of shale wells is located within the hamlet adjacent to the west side of Twelve Mile Creek.

The reported well yield and capacity information for the 32 selected wells are summarized in the following table:

| | |
|---|---|
| Yield Range (l/min) | 2.2 - 22 |
| Mean Yield (l/min) | 6.7 |
| Specific Capacity Range (l/min/metre) | 0.1 - 30 |
| Mean Specific Capacity (l/min/metre) | 0.75 |
| Available Drawdown Range (metres) | 1.5 - 17 |
| Mean Available Drawdown (metres) | 8.6 |
| Percentage of Wells Yielding Less than 14 l/min (3 gpm) | 62 |

The above data indicate that the shale bedrock is a poor water-yielding formation. The apparent transmissivity of about 1.5 $m^3$/day/metre (100 gpd/foot) suggests that the fractures and bedding planes are small and/or sparse in distribution.

Comparing the mean capacity and drawdown results, the aquifer does not appear capable of a larger yield. Wells extended into the deeper shale formation did not generally yield larger water supplies than the shallower wells, indicating that the main fracture systems occur near the overburden-bedrock contact.

4.5.3 Overburden

The main overburden aquifers comprise outwash sand and gravel, generally distributed within the extensive bedrock depression beneath the easterly two-thirds of the study area.

The reported yield and capacity of the 25 selected overburden wells is tabulated as follows:

| | |
|---|---|
| Yield Range (l/min) | 5 - 130 |
| Mean Yield (l/min) | 36 |
| Specific Capacity Range (l/min/metre) | 1.5 - 225 |
| Mean Specific Capacity (l/min/metre) | 9.0 |
| Available Drawdown (metres) | 1.2 - 13.1 |
| Mean Available Drawdown (metres) | 6.1 |
| Percentage of Wells Yielding Less than 14 l/min (3 gpm) | 12 |

The above well information indicates that the overburden aquifer is generally capable of supplying adequate domestic supplies, having an apparent transmissivity of about 13 $m^3$/day/metre (900 gpd/foot). In general, there appears to be a direct relation between the well yield and saturated thickness with the better yields obtained in the areas with saturated thickness of about 10 metres, and the lower yields in areas with saturated thickness less than 3 metres.

Interpretation of the capacity and drawdown data suggests that the aquifer is capable of a somewhat larger yield than reported for the analyzed wells.

## 4.6 GROUNDWATER QUALITY

Water samples were collected from drilled wells completed in the main aquifers at Kilbride. The analyses for the common chemical constituents are listed in the following table:

| Well Number<br>Aquifer | 5<br>Dolomite | 55<br>Overburden | 60<br>Shale |
|---|---|---|---|
| Total Hardness | 245 | 280 | 300 |
| Total Alkalinity | 215 | 225 | 210 |
| Total Iron | Less 0.05 | 0.05 | 0.10 |
| Chloride | 13 | 20 | 530 |
| Sulphate | 37 | 23 | 65 |
| Nitrate | Less 0.5 | 4 | Less 0.5 |
| pH | 7.5 | 7.3 | 7.4 |

(The above analyses except for pH, are expressed in milligrams/litres).

The analyses indicate that the groundwater chemical quality is very similar in each of the defined aquifers with the sampled constituents at a concentration acceptable for domestic use, with the exception of the elevated chloride content in the shale aquifer.

The water sample from the shale also contained a perceptible concentration of hydrogen sulphide gas, and was collected from the deepest well in the study area to evaluate the characteristics of the lower formation. Commonly, the shale wells terminate a short distance below the overburden-bedrock contact, and should have a low chloride concentration, as detected in the overburden aquifer. Deep drilling in the shale bedrock should be discouraged considering the presence of mineralized water having chemical constituents in excess of public drinking-water standards.

A noteworthy analysis is the nitrate concentration of 4 mg/litre in the overburden well sample. Normally, nitrate is found at a concentration of less than one mg/litre, as detected in the dolomite and shale well samples, and this higher concentration may indicate a local nitrate build-up within the aquifer or access of effluent to the well source.

# 5.0 FUTURE DEVELOPMENT

## 5.1 DEVELOPMENT CONSIDERATIONS

Considerations which affect the potential development in any area include water-supply and sewage dilution requirements; available groundwater recharge; direction of groundwater movement; and the impact on existing development.

### 5.1.1 Household Water Supply

Although sufficient water may be available daily from an aquifer system, local residents may consider the aquifer as a deficient source if it is unable to supply the peak water supply on demand. For example, a shale aquifer overlain by granular sediments is recharged at a rate that is readily capable of providing the daily water requirement of a household; however, as the normal water demand is essentially concentrated in two specific periods of about one-hour duration, the aquifer, typically a low permeability and low direct yield, may not meet this demand and may be classified as a poor water source.

An "adequate" domestic supply has not been specifically defined by any provincial or federal agency, being dependent on several contributing parameters such as well yield and storage availability. Nevertheless, a reasonable estimate may be developed by evaluation of the anticipated residential water demand.

Considering that an average household comprises four persons, each with a water demand of 0.23 cubic metres (50 gallons),[13] and allowing a fifty-percent contingency, the daily internal water requirement may be about 1.3 cubic metres (300 gallons). This supply is largely required during

the two peak periods, occurring in the morning and evening, and may be distributed equally between the periods, resulting in an estimated peak hourly demand of 0.68 cubic metres/hour (150 gph). To provide this supply, a well system may depend on the aquifer capability and the storage within the pressure system.

The availability of storage within a pressure system should not be overestimated, as for instance, the largest commonly used "precharged" storage tank has a volume of 0.45 cubic metres (100 gallons) of which only 0.1 cubic metres (25 gallons) may be utilized in the normal pressure range.

Thus, with conventional storage, a well capable of supplying at least 9 litres/minute ( 2 gpm) for a continuous period of at least one hour may be defined as a minimal "adequate" domestic water source.

Appropriate corrective action for homes supplied with lower yield wells, may include:

i) the modification of the household water-use pattern, which would significantly differ from that in a serviced municipal area. Such modifications would be particularly difficult for former residents of serviced municipalities.

ii) the addition of a large-volume storage reservoir or cistern and a second pumping system. The well system would discharge at a low rate directly to the storage reservoir. Pumping from the reservoir by the

second system would be at the demand rate of the household. In this manner, it would be feasible to utilize a well having a yield as low as 4.5 litres/min (one gpm). Below this yield, a drilled well should not be considered as a reliable water source, as prolonged pumping may be required to sustain the domestic water requirement.

In any new development, the builder should be required to install a water-supply system capable of providing at least the one-hour peak demand from the combined well and storage system. The latter can only be ascertained by the specific testing of a supply well on the lot to determine the well yield and the make-up water requirement.

5.1.2 Lawn Watering

Lawn irrigation occurs over a short interval of about ten weeks annually, but may require a substantial volume of water, about 25.4 mm (one inch) per week, to maintain desireable grass growth. This estimated irrigation demand is similar to the actual withdrawal during recent summers in a residential subdivision within the Region.[13]

During July and August, the available moisture from precipitation averages about 16.9 mm (0.67 inches) per week,[14] leaving a deficiency of about 8.5 mm (0.33 inches) weekly. Comparison of the potential evapotranspiration and the actual precipitation[15] for this period, yielded similar results, and indicated a moisture deficiency of about 100 mm (4 inches).

To provide this makeup supply, an irrigation system would be required to provide water at a rate of about 12.5 $m^3$/day/hectare (1100 gpd/acre), equivalent to a continuous discharge of 8.6 litres/min/hectare during the entire irrigation period.

Another critical factor is the cumulative effect of the groundwater withdrawal, which would annually amount to about 850 $m^3$/hectare, or 2.4 $m^3$/day/hectare (210 gpd/acre). Recalling that the estimated recharge in the till and granular areas is about 2.6 $m^3$/day/hectare and 4.0 $m^3$/day/hectare, respectively, it is readily apparent that large irrigation withdrawals would seriously impact the groundwater regime.

Realistically, it may be anticipated that a part of the lot will be maintained as a lawn area, possibly about 0.2 hectares (0.5 acres) in the vicinity of the house. The impact on the groundwater system would be about 170 $m^3$ annually and would be readily supplied by a well operating at 9 litres/min (2 gpm) for an average period of about 4½-hours daily, at a time other than a peak-demand period, during the irrigation period.

### 5.1.3 Septic System Discharge

The daily household withdrawal is largely returned to the sub-surface through the septic-tile field. The sewage effluent is adequately treated for the removal of bacteria where a thick sequence of unsaturated soil is available; however, the effluent contains certain conservative chemical constituents, principally chloride and nitrate, which eventually reach the water table and potential water-supply sources, particularly in a shallow setting.

The maximum recommended concentrations for chloride and nitrate in public-water supplies has been set at 250 mg/l and 10 mg/l, respectively, whereas these constituents have been found in septic-tank effluent at concentrations of about 80 mg/l and 40 mg/l, in studies conducted by the Ontario Ministry of the Environment.[16,17] The presence of chloride does not constitute a problem; however, nitrate, when present in elevated concentrations is considered hazardous to the health of infants. Dilution is required to effectively maintain the nitrate content at an acceptable concentration, and is normally provided by infiltrating precipitation and/or groundwater moving laterally through the disposal area.

As the average household generates about one cubic metre/day (200 gpd) of sewage effluent, a dilution water supply of about three cubic metres/day (600 gpd) is required to effectively reduce the nitrate concentration in the infiltrating water below the maximum drinking-water standard.

### 5.1.4 Residential Lot Area

Within a self-sustaining community, the available groundwater recharge must be adequate to balance the household water demand, the septic-sewage dilution and the lawn-watering requirements in perpetuity.

Based on the preceding discussion, the daily water demand of a residential household averaging 3.8 occupants[18] is calculated to be about 3.1 cubic metres (700 gallons).

From the water-table configuration maps, the recharge within the Kilbride study area is recognized to largely occur as infiltrating precipitation. Consequently, the recharge area for each residence may be determined by dividing the water demand by the infiltration capacity of the surficial soils. Lot areas of 0.8 hectares (2 acres) are required for residences in areas where the surface materials comprise bedrock, thin drift over bedrock, and granular sediments; and of 1.2 hectares (3 acres) for residences where the service materials comprise silty till. Should more than 0.5 hectare/lot be irrigated, the lot areas should be increased by one hectare in the till area and by 0.6 hectare in the other areas for each additional irrigated hectare.

Development may proceed by placing each residence on an appropriate-size lot, dictated by the surficial soils, or by clustering the residences on smaller lots, with adjacent open-space areas. Utilization of large lots would encourage better recharge capture, and would,as importantly, allow development in most areas without impacting on adjacent lands. Clustering of the lots would potentially provide for agricultural or recreational uses of the open lands, but would necessitate detailed studies to ensure adequate groundwater flow to the development areas.

## 5.2 HYDROGEOLOGIC AREAS

The Kilbride study area may be subdivided into three distinct sub-areas according to the defined geologic and groundwater conditions, designated for discussion purposes as the

northwest area, the northeast area and the southern area as shown on Map 2.

5.2.1 Northwest Area

The area is characterized by a thin overburden complex, comprising gravelly till and sand, ranging from zero to 5 metres in thickness, that directly overlies the dolomite bedrock. The principal groundwater divide traverses diagonally through the area, and much of the groundwater bypasses the hamlet, towards eventual discharge at Bronte and Twelve Mile Creeks.

Adequate water supplies are widely developed from the dolomite bedrock, which locally yields between 9 to 45 litres/minute (2 to 10 gpm), and averages about 30 litres/minute (7 gpm) to drilled wells. The well yields are closely related to the bedrock thickness, with the larger yields occurring at the westerly limits,where the bedrock exceeds 10 metres and the lowest yields along the easterly limits, where the dolomite is less than 3 metres.

Although, the individual lots may be 0.8 hectares (2 acres) in area, the relative absence of soil cover remains a serious concern, as extensive movement of bacteria is possible through the bedrock fractures. Implementation of the recommendations in the Rural Servicing Study[5] on overburden thickness would preclude much new residential development in this defined area.

Based only on the well-yield capability and potential quality impact on the existing community, the preferred development area is situated west of Mc Niven Road. Development in the area east of the groundwater divide and adjacent to the community may stress the developed groundwater sources within the hamlet.

### 5.2.2 Northeast Area

The area is underlain by shale bedrock, being situated below the buried escarpment, and is entirely mantled with glacial drift. The thickest overburden section, exceeding 20 metres, occurs within the bedrock depression extending beneath the creek at Kilbride. In the adjacent upland extending to the easterly limit, the overburden thickness is fairly uniform, ranging from about 10 to 13 metres.

The principal groundwater divide extends along the east bank of Twelve Mile Creek and generally coincides with the geologic boundary between the outwash materials within the creek valley and the silty till in the upland area.

Water supplies are mainly developed from a sand and gravel aquifer directly overlying the shale bedrock, with a saturated thickness ranging from about 3 to 10 metres. Individual well yields range from 18 litres/minute (4 gpm) to about 135 litres/minute (30 gpm), and average about 45 litres/minute (10 gpm). Where the overburden is thin, as within Kilbride west of the creek, water supplies are obtained from the shale bedrock. Yield from these bedrock wells are the lowest within the entire study area, generally averaging about 4 litres/minute (one gpm), and account for the reports that local wells are occassionally supplemented by cisterns.

The individual lot area for any development east of the groundwater divide should be 1.2 hectares (3 acres), being underlain by clay till with moderately low infiltration capacity. Development of septic-tank systems should not affect the bacterial quality of the groundwater, as the unsaturated zone generally exceeds 3 metres in depth and should provide considerable attenuation.

West of the divide and north of the hamlet, the lot areas may be 0.8 hectares (2 acres). Some difficulty may be expected with the installation of conventional septic-tank systems due to high local water-table conditions.

Additional development within the hamlet, which is largely situated within the northeast area should be discouraged based on the apparent distribution of the present population of about 500 persons and the limited contributing recharge area, as delineated by the groundwater divides. Preliminary calculations indicate that sufficient groundwater may not be available to meet the water-supply requirements; however, the actual water use may be much lower than the calculated requirement due to the minimal well yields, and quality or quantity problems may be localized or absent.

Development of the areas east of the groundwater divide and north of the hamlet should have no effect on the existing well supplies, as the recharge does not contribute to the groundwater availability of existing wells.

### 5.2.3 Southern Area

The area essentially delineates the outwash terrace, which exceeds 45 metres in thickness, and is underlain by the shale bedrock. The terrace has been extensively mined along much of its exposure and has been deeply incised by Twelve Mile Creek, with the result that the water table is locally depressed.

Due to the drained condition of the granular materials, water supplies from drilled wells are commonly obtained from the shale bedrock. Where perched layers locally occur, wells have been completed at shallow depths within the overburden. The yields of the overburden and bedrock wells are similar to that of the other areas, with the overburden yielding larger supplies than the bedrock.

Lot areas may be about 0.3 hectares (? acres) within any future development, being largely underlain by permeable granular materials. Quality problems would not be anticipated with septic-tank systems in view of the thick unsaturated overburden overlying the basal aquifers. It is expected that most water-supply wells will be deep, likely terminating in the shale bedrock, and will yield small to marginal quantities of water.

Groundwater movement is generally southward with discharge occurring at Twelve Mile and Bronte Creeks, and new development in this area will not impact on local wells or the hamlet.

## 5.3 PHASING

The water-level contour maps indicate that residential development may proceed throughout much of the three defined areas without phasing, as negligible impact is anticipated on the quality and quantity of well supplies within the hamlet.

Overall, based on the water-supply and septic-tank requirements for a residential subdivision, the best development area is the northeast area, with good water-supply potential and good protection to the aquifer from septic-system contamination; followed by the northwest area with good water-supply potential and fair to poor aquifer protection; and then the southern area with fair to moderate yield potential and fair to good aquifer protection.

## 5.4 TESTING REQUIREMENTS

The potential of the Kilbride area to sustain additional development, based on the anticipated residential water demand, is exhibited on Map 3. This interpretation

has been essentially developed from the geologic and groundwater information provided in the logs of the local drilled wells. These data are adequate for an overall appraisal of the yield capability and distribution of the aquifers, the infiltration capabilities of the surficial sediments, the direction of groundwater movement, and the preparation of general development guidelines. However, field testing will be required to determine the local hydrogeologic conditions at any proposed development and to confirm the potential impact on existing groundwater sources.

Testing to establish site-specific conditions may be deferred until draft subdivision approval is obtained, at which time the developer should be required to install one domestic well/four hectares (10 acres), with a minimum of three wells for any development plan. These wells should be drilled at locations that will permit an analysis by a professional hydrogeologist of the direction of groundwater movement; the nature of the overburden sediments; the well and aquifer yields, and the quality and quantity impact on the existing and proposed developments. Modifications to the proposed lot areas or the placement of residences would be finalized on the basis of the field testing.

Should the Region desire to establish the prevailing groundwater flow and infiltration conditions prior to any development, considerable field work would be required, comprising the installation of eight piezometers or piezometer nests, into the main aquifer system in each of the northwest and northeast areas; the conductance of falling-head or recovery tests to evaluate the local conductivity; short-term monitoring to assess recharge and groundwater

movement; mechanical analyses of soil samples to determine the permeability of the overburden and suitability for septic-system operation. The testing of the two areas would cost about $10,000. and would require about two months for completion.

Such testing would not be necessary in the southern area, as the topography and mining activity strongly direct groundwater movement away from the hamlet and the thick overburden cover provides ample protection to the underlying groundwater sources.

Respectfully submitted,

HYDROLOGY CONSULTANTS LIMITED

Leon G. Bryck, P. Eng.

APPENDIX A: Representative Water Well Data

NOTES

1) Data provided in this Appendix are listed as shown in the Ministry of the Environment files. Measurements in feet may be converted to metres by multiplying by 0.3048 and measurements in gallons per minute may be converted to litres per minute by multiplying by 4.5.

2) Reference in the following well logs to "limestone", should correctly be read as "dolomite".

REGIONAL MUNICIPALITY OF HALTON
KILBRIDE HYDROGEOLOGIC INVESTIGATION
TABLE OF REPRESENTATIVE
WATER-WELL RECORDS

| Well No. | Particulars | | |
|---|---|---|---|
| 1 | MOE No: 4932 | Elevation: 900 ft. | |
| | Pumping Rate: 4 gpm | Quality: Fresh | |
| | Static Level: 125 ft. | Pumping Level: 182 ft. | |
| | Geologic Log: Clay and gravel 173; red clay 178; grey clay 182; sandstone 183; shale 195 ft. | | |
| 2 | MOE No: 2821 | Elevation: 870 ft. | |
| | Pumping Rate: 30 gpm | Quality: Fresh | |
| | Static Level: 15 ft. | Pumping Level: 35 ft. | |
| | Geologic Log: Sand, gravel and stones 35; limestone 49 ft. | | |
| 3 | MOE No: 2831 | Elevation: 860 ft. | |
| | Pumping Rate: 6 gpm | Quality: Fresh | |
| | Static Level: 25 ft. | Pumping Level: 50 ft. | |
| | Geologic Log: Sand and gravel 23; clay and stones 37; limestone 47; shale 55 ft. | | |
| 4 | MOE No: 390 | Elevation: 880 ft. | |
| | Pumping Rate: 150 gph | Quality: Fresh | |
| | Static Level: 25 ft. | Pumping Level: 130 ft. | |
| | Geologic Log: Old drilled well 70; shale 130 ft. | | |

| Well No. | Particulars | |
|---|---|---|
| 5 | MOE No: 4612 | Elevation: 860 ft. |
| | Pumping Rate: 20 gpm | Quality: Fresh |
| | Static Level: 10 ft. | Pumping Level: 14 ft. |
| | Geologic Log: Sand 6; sand, gravel and boulders 9; limestone 32 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 6 | MOE No: 393 | Elevation: 860 ft. |
| | Pumping Rate: 10 gpm | Quality: Fresh |
| | Static Level: 3 ft. | Pumping Level: 6 ft. |
| | Geologic Log: Limestone 27 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 7 | MOE No: 394 | Elevation: 875 ft. |
| | Pumping Rate: 15 gpm | Quality: Fresh |
| | Static Level: 12 ft. | Pumping Level: 32 ft. |
| | Geologic Log: Sand and stones 18; clay 24; limestone 46 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 8 | MOE No: 395 | Elevation: 855 ft. |
| | Pumping Rate: 4 gpm | Quality: Fresh |
| | Static Level: 10 ft. | Pumping Level: bottom |
| | Geologic Log: Silt 1; limestone 35; shale 43 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 9 | MOE No: 396 | Elevation: 855 ft. |
| | Pumping Rate: 6 gpm | Quality: Fresh |
| | Static Level: 10 ft. | Pumping Level: bottom |
| | Geologic Log: Silt 2; limestone 34; shale 38 ft. | |

| Well No. | Particulars | | |
|---|---|---|---|
| 10 | MOE No: 389 | Elevation: 860 ft. | |
| | Pumping Rate: 25 gph | Quality: Fresh | |
| | Static Level: 46 ft. | Pumping Level: 190 ft. | |
| | Geologic Log: Gravel and boulders 48; limestone 58; shale 90 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 11 | MOE No: 397 | Elevation: 870 ft. | |
| | Pumping Rate: 20 gpm | Quality: Fresh | |
| | Static Level: 17 ft. | Pumping Level: 21 ft. | |
| | Geologic Log: Sand 18; clay 27; limestone 50 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 12 | MOE No: 3440 | Elevation: 860 ft. | |
| | Pumping Rate: 7 gpm | Quality: Fresh | |
| | Static Level: 8 ft. | Pumping Level: 24 ft. | |
| | Geologic Log: Sand, clay and boulders 12; limestone 32 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 13 | MOE No: 4423 | Elevation: 860 ft. | |
| | Pumping Rate: 5 gpm. | Quality: Fresh | |
| | Static Level: 4 ft. | Pumping Level: 38 ft. | |
| | Geologic Log: Limestone 43; shale 45 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 14 | MOE No: 5161 | Elevation: 855 ft. | |
| | Pumping Rate: 7 gpm | Quality: Fresh | |
| | Static Level: 9 ft. | Pumping Level: 35 ft. | |
| | Geologic Log: Clay 10; limestone 30; shale 39 ft. | | |

| Well No. | Particulars | |
|---|---|---|
| 15 | MOE No: 5302 | Elevation: 860 ft. |
| | Pumping Rate: 3 gpm | Quality: Fresh |
| | Static Level: 7 ft. | Pumping Level: 37 ft. |
| | Geologic Log: Clay 18; limestone 35; shale 37 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 16 | MOE No: 5312 | Elevation: 860 ft. |
| | Pumping Rate: 10 gpm | Quality: Fresh |
| | Static Level: 6 ft. | Pumping Level: 33 ft. |
| | Geologic Log: Silt 2; limestone 33; shale 40 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 17 | MOE No: 2819 | Elevation: 880 ft. |
| | Pumping Rate: 7 gpm | Quality: Fresh |
| | Static Level: 13 ft. | Pumping Level: 40 ft |
| | Geologic Log: Clay and stones 10; limestone 52 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 18 | MOE No: 398 | Elevation: 850 ft. |
| | Pumping Rate: 10 gpm | Quality: Fresh |
| | Static Level: 10 ft. | Pumping Level: 14 ft. |
| | Geologic Log: Sandy clay 6; limestone 25; shale 27 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 19 | MOE No: 399 | Elevation: 865 ft. |
| | Pumping Rate: 400 gph | Quality: Fresh |
| | Static Level: 20 ft. | Pumping Level: bottom |
| | Geologic Log: Boulders and clay 40 ft. | |

| Well No. | Particulars | | |
|---|---|---|---|
| 20 | MOE No: 400 | Elevation: 850 ft. | |
| | Pumping Rate: ½ gpm | Quality: Fresh | |
| | Static Level: 19 ft. | Pumping level: bottom | |
| | Geologic Log: Gravel 19; limestone 26; shale 66 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 21 | MOE No: 401 | Elevation: 895 ft. | |
| | Pumping Rate: 20 gpm | Quality: Fresh | |
| | Static Level: 23 ft. | Pumping Level: 25 ft. | |
| | Geologic Log: Sandy clay 27; limestone rock 31 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 22 | MOE No: 3101 | Elevation: 890 ft. | |
| | Pumping Rate: 30 gpm | Quality: Fresh | |
| | Static Level: 20 ft. | Pumping Level: 25 ft. | |
| | Geologic Log: Sand, gravel and stones 16; limestone 41 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 23 | MOE No: 3875 | Elevation: 860 ft. | |
| | Pumping Rate: 20 gpm | Quality: Fresh | |
| | Static Level: 21 ft. | Pumping Level: 23 ft. | |
| | Geologic Log: Brown clay, sand and gravel 20; grey clay, gravel and boulders 46 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 24 | MOE No: 3904 | Elevation: 860 ft. | |
| | Pumping Rate: 10 gpm | Quality: Fresh | |
| | Static Level: 8 ft. | Pumping Level: 13 ft. | |
| | Geologic Log: Sand 5; limestone 33 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 25 | MOE No: 4310 | Elevation: 875 ft. | |
| | Pumping Rate: 7 gpm | Quality: Fresh | |
| | Static Level: 16 ft. | Pumping Level: 44 ft. | |
| | Geologic Log: Sand boulders 10; limestone 51 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 26 | MOE No: 4079 | Elevation: 875 ft. | |
| | Pumping Rate: 20 gpm | Quality: Fresh | |
| | Static Level: 1 ft. | Pumping Level: 3 ft. | |
| | Geologic Log: Clay boulders 10; limestone 20 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 27 | MOE No: 4330 | Elevation: 730 ft. | |
| | Pumping Rate: 10 gpm | Quality: Fresh | |
| | Static Level: 28 ft. | Pumping Level: 63 ft. | |
| | Geologic Log: Sand and gravel 74; shale 76 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 28 | MOE No: 3947 | Elevation: 775 ft. | |
| | Pumping Rate: 1 gpm | Quality: Fresh | |
| | Static Level: 16 ft. | Pumping Level: 68 ft. | |
| | Geologic Log: Silty clay 16; clay 39; green shale 46; sandstone 58; red shale 70 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 29 | MOE No: 452 | Elevation: 820 ft. | |
| | Pumping Rate: 3/4 gpm | Quality: Fresh | |
| | Static Level: 45 ft. | Pumping Level: bottom | |
| | Geologic Log: Gravel and boulders 16; clay 28; sand and gravel 54; sand and clay 68; sandstone 68; shale 86 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 30 | MOE No: 453 | Elevation: 775 ft. | |
| | Pumping Rate: 2 gpm | Quality: Fresh | |
| | Static Level: 27 ft. | Pumping Level: 34 ft. | |
| | Geologic Log: Sand and gravel 16; boulders and sand 27; gravel 32; sandy clay 34 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 31 | MOE No: 4050 | Elevation: 775 ft. | |
| | Pumping Rate: 3 gpm | Quality: Fresh | |
| | Static Level: 27 ft. | Pumping Level: 45 ft. | |
| | Geologic Log: Medium sand 19; clay 25; coarse sand 27; clay 27½; medium sand 48 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 32 | MOE No: 450 | Elevation: 810 ft. | |
| | Pumping Rate: 75 gph | Quality: Fresh | |
| | Static Level: 17 ft. | Pumping Level: 34 ft. | |
| | Geologic Log: Shale 49 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 33 | MOE No: 2817 | Elevation: 810 ft. | |
| | Pumping Rate: 4½ gpm | Quality: Fresh | |
| | Static Level: 22 ft. | Pumping Level: 35 ft. | |
| | Geologic Log: Sandy soil 20; brown sand 45; clay 60; sandstone 68; shale 100 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 34 | MOE No: 4206 | Elevation: 800 ft. | |
| | Pumping Rate: 1 gpm | Quality: Fresh | |
| | Static Level: 40 ft. | Pumping Level: 97 ft. | |
| | Geologic Log: Clay 57; sand 60; shale 72; sandstone 77; blue shale 79; red shale 101 ft. | | |

| Well No. | Particulars |
|---|---|
| 35 | MOE No: 4442 Elevation: 780 ft.<br>Pumping Rate: 2 gpm. Quality: Fresh<br>Static Level: 45 ft. Pumping Level: 98 ft.<br>Geologic Log: Sandy loam 8; clay gravel 56; limestone 66; grey shale 75; red shale 100 ft. |

| Well No. | Particulars |
|---|---|
| 36 | MOE No: 4944 Elevation: 850 ft.<br>Pumping Rate: 2 gpm Quality: Fresh<br>Static Level: 10 ft. Pumping Level: 33 ft.<br>Geologic Log: Sand and gravel 6; limestone 36; shale 38 ft. |

| Well No. | Particulars |
|---|---|
| 37 | MOE No: 5210 Elevation: 835 ft.<br>Pumping Rate: 8 gpm Quality: Fresh<br>Static Level: 84 ft. Pumping Level: 89 ft.<br>Geologic Log: Sand and Gravel 23; sandy clay 79; fine sand 96; limestone 98 ft. |

| Well No. | Particulars |
|---|---|
| 38 | MOE No: 5225 Elevation: 775 ft.<br>Pumping Rate: - Quality: Fresh<br>Static Level: - Pumping Level: -<br>Geologic Log: Sandy clay 85; grey clay 95; sandy clay 143; shale 180 ft. |

| Well No. | Particulars |
|---|---|
| 39 | MOE No: 4149 Elevation: 810 ft.<br>Pumping Rate: 3 gpm Quality: Fresh<br>Static Level: 40 ft. Pumping Level: 90 ft.<br>Geologic Log: Clay 8; gravel 20; clay 64; shale 95 ft. |

| Well No. | Particulars | | |
|---|---|---|---|
| 40 | MOE No: 459 | Elevation: 830 ft. | |
| | Pumping Rate: 1 gpm | Quality: Fresh | |
| | Static Level: 20 ft. | Pumping Level: 30 ft. | |
| | Geologic Log: Green shale 59 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 41 | MOE No: 463 | Elevation: 825 ft. | |
| | Pumping Rate: 2 gpm | Quality: Fresh | |
| | Static Level: 42 ft. | Pumping Level: 60 ft. | |
| | Geologic Log: Gravel 30; clay and sand 57; shale 70; sandstone 85 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 42 | MOE No: 464 | Elevation: 820 ft. | |
| | Pumping Rate: 3 gpm | Quality: Fresh | |
| | Static Level: 15 ft. | Pumping Level: 35 ft. | |
| | Geologic Log: Clay 10; red and blue shale 35 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 43 | MOE No: 465 | Elevation: 825 ft. | |
| | Pumping Rate: 10 gpm | Quality: Fresh | |
| | Static Level: 32 ft. | Pumping Level: 34 ft. | |
| | Geologic Log: Clay and gravel 35; sand and clay 47; clay, sand and gravel 56; clay and gravel 63; clay and sand 65 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 44 | MOE No: 467 | Elevation: 830 ft. | |
| | Pumping Rate: 5 gpm | Quality: Sulphur | |
| | Static Level: 36 ft. | Pumping Level: 51 ft. | |
| | Geologic Log: Stones & clay 23; sand & clay 38; hard pan 46; clay & gravel 56; sand 58; clay 74; shale 100 ft. - Abandoned | | |

| Well No. | Particulars | |
|---|---|---|
| 45 | MOE No: 468 | Elevation: 820 ft. |
| | Pumping Rate: 5 gpm | Quality: Fresh |
| | Static Level: 13 ft. | Pumping Level: 33 ft. |
| | Geologic Log: Clay 13; shale 35 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 46 | MOE No: 469 | Elevation: 840 ft. |
| | Pumping Rate: 5 gpm | Quality: Fresh |
| | Static Level: 15 ft. | Pumping Level: Bottom |
| | Geologic Log: Clay 6; limestone 30 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 47 | MOE No: 471 | Elevation: 830 ft. |
| | Pumping Rate: 1 gpm | Quality: Fresh |
| | Static Level: 13 ft. | Pumping Level: Bottom |
| | Geologic Log: Clay 13; shale 51 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 48 | MOE No: 474 | Elevation: 820 ft. |
| | Pumping Rate: 8 gpm | Quality: Fresh |
| | Static Level: 28 ft. | Pumping Level: 57 ft. |
| | Geologic Log: Gravel, sand and clay 45; quicksand 63; gravel and sand 71; limestone 74 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 49 | MOE No: 475 | Elevation: 805 ft. |
| | Pumping Rate: 1½ gpm | Quality: Fresh |
| | Static Level: 18 ft. | Pumping Level: 65 ft. |
| | Geologic Log: Clay and stones 20; silt 47; limestone 52; shale 68 ft. | |

| Well No. | Particulars | | |
|---|---|---|---|
| 50 | MOE No: 476 | Elevation: 810 ft. | |
| | Pumping Rate: 10 gpm | Quality: Fresh | |
| | Static Level: 26 ft. | Pumping Level: 29 ft. | |
| | Geologic Log: Silt 7; sand & gravel 34; clay, sand & gravel 39; gravel 43; sandy clay 44 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 51 | MOE No: 478 | Elevation: 840 ft. | |
| | Pumping Rate: 50 gph | Quality: Fresh | |
| | Static Level: 23 ft. | Pumping Level: Bottom | |
| | Geologic Log: Sand and clay 25; shale 64 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 52 | MOE No: 470 | Elevation: 850 ft. | |
| | Pumping Rate: 5 gpm | Quality: Fresh | |
| | Static Level: 15 ft. | Pumping Level: Bottom | |
| | Geologic Log: Clay 9; limestone 30 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 53 | MOE No: 2835 | Elevation: 820 ft. | |
| | Pumping Rate: 10 gpm | Quality: Fresh | |
| | Static Level: 30 ft. | Pumping Level: 40 ft. | |
| | Geologic Log: Clay and stones 35; sand 65 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 54 | MOE No: 3503 | Elevation: 820 ft. | |
| | Pumping Rate: 14 gpm | Quality: Fresh | |
| | Static Level: 30 ft. | Pumping Level: 34 ft. | |
| | Geologic Log: Clay and stones 5; gravel 12; clay 28; sand 33; gravel 35; clay 35 ft. | | |

| Well No. | Particulars |
|---|---|
| 55 | MOE No: 3767 Elevation: 810 ft.<br>Pumping Rate: 5 gpm Quality: Fresh<br>Static Level: 26 ft. Pumping Level: 35 ft.<br>Geologic Log: Clay 4; sand 8; clay 10; medium sand 14; clay 19; medium sand 20; coarse sand 42½ ft. |
| 56 | MOE No: 3798 Elevation: 810 ft.<br>Pumping Rate: 5 gpm Quality: Fresh<br>Static Level: 26 ft. Pumping Level: 35 ft.<br>Geologic Log: Clay 4; sand and gravel 18; clay 20; medium sand 43 ft. |
| 57 | MOE No: 3825 Elevation: 820 ft.<br>Pumping Rate: 4 gpm Quality: Fresh<br>Static Level: 21 ft. Pumping Level: 39 ft.<br>Geologic Log: Silt 7; clay 33; sand 44; sand, silt and gravel 50; sand 57; bedrock 61 ft. |
| 58 | MOE No: 3870 Elevation: 860 ft.<br>Pumping Rate: 2 gpm Quality: Fresh<br>Static Level: 3 ft. Pumping Level: 31 ft.<br>Geologic Log: Silty clay 9; limestone 33 ft. |
| 59 | MOE No: 4209 Elevation: 850 ft.<br>Pumping Rate: 6 gpm Quality: Fresh<br>Static Level: 5 ft. Pumping Level: 30 ft.<br>Geologic Log: Silt 6; limestone 35 ft. |

| Well No. | Particulars | |
|---|---|---|
| 60 | MOE No: 4710 | Elevation: 820 ft. |
| | Pumping Rate: 3 gpm | Quality: Sulphur |
| | Static Level: 23 ft. | Pumping Level: 110 ft. |
| | Geologic Log: Clay 55; shale 150 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 61 | MOE No: 479 | Elevation: 815 ft. |
| | Pumping Rate: 30 gpm | Quality: Fresh |
| | Static Level: 10 ft. | Pumping Level: 25 ft. |
| | Geologic Log: Clay 30; sand 42; gravel 44 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 62 | MOE No: 3549 | Elevation: 850 ft. |
| | Pumping Rate: 2 gpm | Quality: Fresh |
| | Static Level: 10 ft. | Pumping Level: 29 ft. |
| | Geologic Log: Limestone 29; shale 31 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 63 | MOE No: 3376 | Elevation: 860 ft. |
| | Pumping Rate: 2 gpm | Quality: Fresh |
| | Static Level: 3 ft. | Pumping Level: 27 ft. |
| | Geologic Log: Silt 4; limestone 27; shale 31 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 64 | MOE No: 3807 | Elevation: 860 ft. |
| | Pumping Rate: 2 gpm | Quality: Fresh |
| | Static Level: 14 ft. | Pumping Level: 28 ft. |
| | Geologic Log: Sand 8; limestone 40 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 65 | MOE No: 3900 | Elevation: 840 ft. |
| | Pumping Rate: 30 gpm | Quality: Fresh |
| | Static Level: 4 ft. | Pumping Level: 4 ft |
| | Geologic Log: Clay 28; sand and gravel 30 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 66 | MOE No: 3926 | Elevation: 850 ft. |
| | Pumping Rate: 2 gpm | Quality: Fresh |
| | Static Level: 6 ft. | Pumping Level: 35 ft. |
| | Geologic Log: Clay 9; limestone 36; shale 40 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 67 | MOE No: 4533 | Elevation: 825 ft. |
| | Pumping Rate: 8 gpm | Quality: Fresh |
| | Static Level: 11 ft. | Pumping Level: 15 ft. |
| | Geologic Log: Clay 23; clay and sand 30; sand 34 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 68 | MOE No: 4566 | Elevation: 820 ft. |
| | Pumping Rate: 10 gpm | Quality: Fresh |
| | Static Level: 8 ft. | Pumping Level: 17 ft. |
| | Geologic Log: Clay 15; clay and sand 30; sand 33; clay and sand 35 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 69 | MOE No: 481 | Elevation: 825 ft. |
| | Pumping Rate: 10 gpm | Quality: Fresh |
| | Static Level: 12 ft. | Pumping Level: 25 ft. |
| | Geologic Log: Clay 25; gravel 35 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 70 | MOE No: 480 | Elevation: 860 ft. |
| | Pumping Rate: 1/5 gpm | Quality: Fresh |
| | Static Level: 36 ft. | Pumping Level: 99 ft. |
| | Geologic Log: Sand and gravel 40; clay-sand and gravel 55; clay and soft shale 60; shale 70; grey and red shale 113 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 71 | MOE No: 2816 | Elevation: 830 ft. |
| | Pumping Rate: 4 gpm | Quality: Fresh |
| | Static Level: 5 ft. | Pumping Level: 38 ft. |
| | Geologic Log: Clay 12; shale 40 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 72 | MOE No: 2813 | Elevation: 830 ft. |
| | Pumping Rate: ½ gpm | Quality: Fresh |
| | Static Level: 5 ft. | Pumping Level: 67 ft. |
| | Geologic Log: Clay 14; shale 67 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 73 | MOE No: 3953 | Elevation: 860 ft. |
| | Pumping Rate: 4 gpm | Quality: Fresh |
| | Static Level: 24 ft. | Pumping Level: 39 ft |
| | Geologic Log: Silty clay 19; gravel and clay 36; sand 39; clay and gravel 45 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 74 | MOE No: 3003 | Elevation: 890 ft. |
| | Pumping Rate: 15 gpm | Quality: Fresh |
| | Static Level: 17 ft. | Pumping Level: 36 ft. |
| | Geologic Log: Loam 5, limestone 42 ft. | |

| Well No. | Particulars | | |
|---|---|---|---|
| 75 | MOE No: 3322 | Elevation: 870 ft. | |
| | Pumping Rate: 1 gpm | Quality: Fresh | |
| | Static Level: 17 ft. | Pumping Level: 41 ft. | |
| | Geologic Log: Silt 5; limestone 38; shale 44 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 76 | MOE No: 4170 | Elevation: 885 ft. | |
| | Pumping Rate: 2 gpm | Quality: Fresh | |
| | Static Level: 4 ft. | Pumping Level: 35 ft. | |
| | Geologic Log: Limestone 40 ft. | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 77 | MOE No: 3447 | Elevation: 800 ft. | |
| | Pumping Rate: - | Quality: - | |
| | Static Level: - | Pumping Level: - | |
| | Geologic Log: Clay 6; sand 54; clay boulders 64; clay and gravel 74; clay and silt 89; red shale 101 ft. Abandoned | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 78 | MOE No: 3479 | Elevation: 800 ft. | |
| | Pumping Rate: - | Quality: - | |
| | Static Level: - | Pumping Level: - | |
| | Geologic Log: Clay 10; clay and sand 27; clay 91; shale 95 ft. Abandoned | | |

| Well No. | Particulars | | |
|---|---|---|---|
| 79 | MOE No: 517 | Elevation: 780 ft. | |
| | Pumping Rate: 2 gpm | Quality: Fresh | |
| | Static Level: 12 ft. | Pumping Level: 22 ft. | |
| | Geologic Log: Clay 4; gravel 9; clay 12; sand and gravel 19; clay 22; rock at 22 ft. | | |

| Well No. | Particulars |
|---|---|
| 80 | MOE No: 518 Elevation: 750 ft.<br>Pumping Rate: 3 gpm Quality: Fresh<br>Static Level: 10 ft. Pumping Level: 18 ft.<br>Geologic Log: Sandy clay 9; sandy gravel 13; clay 16; rock 18 ft. |
| 81 | MOE No: 3583 Elevation: 820 ft.<br>Pumping Rate: - Quality: Fresh<br>Static Level: 24 ft. Pumping Level: 30 ft.<br>Geologic Log: Clay 12; coarse sand 28; hardpan and clay 30 ft. |
| 82 | MOE No: 3673 Elevation: 820 ft.<br>Pumping Rate: 30 gpm Quality: Fresh<br>Static Level: 24 ft. Pumping Level: 26 ft.<br>Geologic Log: Clay 10; shale 10; cemented gravel 15; sand and gravel 30 ft; shale at 30 ft. |
| 83 | MOE No: 5085 Elevation: 820 ft.<br>Pumping Rate: 30 gpm Quality: Fresh<br>Static Level: 1 ft. Pumping Level: 25 ft.<br>Geologic Log: Well pit 8; grey rock 23; shale 38 ft. |
| 84 | MOE No: 526 Elevation: 830 ft.<br>Pumping Rate: 5 gpm Quality: Fresh<br>Static Level: 14 ft. Pumping Level: 22 ft.<br>Geologic Log: Clay 18; shale 34 ft. |

| Well No. | Particulars | |
|---|---|---|
| 85 | MOE No: 527 | Elevation: 880 ft. |
| | Pumping Rate: 5 gpm | Quality: Fresh |
| | Static Level: 14 ft. | Pumping Level: Bottom |
| | Geologic Log: Clay 8; limestone 24; shale 32 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 86 | MOE No: 3000 | Elevation: 825 ft. |
| | Pumping Rate: 8 gpm | Quality: Fresh |
| | Static Level: 15 ft. | Pumping Level: 30 ft. |
| | Geologic Log: Clay 10; sand and gravel 30; gravel 33 ft. | |

| Well No. | Particulars | |
|---|---|---|
| 87 | MOE No: 3235 | Elevation: 825 ft. |
| | Pumping Rate: - | Quality: Fresh |
| | Static Level: 14 ft. | Pumping Level: - |
| | Geologic Log: Silt 13; sand 17; clay 33; shale 50; sandstone 61; shale 62 ft. | |

| Well No. | Particulars | |
|---|---|---|
| | MOE No: | Elevation: |
| | Pumping Rate: | Quality: |
| | Static Level: | Pumping Level: |
| | Geologic Log: | |

| Well No. | Particulars | |
|---|---|---|
| | MOE No: | Elevation: |
| | Pumping Rate: | Quality: |
| | Static Level: | Pumping Level: |
| | Geologic Log: | |

# APPENDIX B: BIBLIOGRAPHY

# BIBLIOGRAPHY


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APPENDIX C: Terms of Reference

REGIONAL MUNICIPALITY OF HALTON

PUBLIC WORKS DEPARTMENT

TERMS OF REFERENCE

HYDROGEOLOGICAL INVESTIGATION FOR THE HAMLET OF KILBRIDE

PROJECT NO. PR-597

## A. INTRODUCTION

The purpose of the Study is to determine the adequacy of long term groundwater supply to support new development in the Kilbride area without detriment to existing ratepayers. As the findings of this study will provide an input into the decision making process relative to future growth, it is important that information, upon which the recommendations are based, be as accurate as is practical.

## B. TERMS OF REFERENCE

1. The Study will evaluate a water supply consisting of individual private wells to serve existing residences and future development.

2. Contact regional staff to obtain current and past well water quantity and quality problems. Advise how future development will impact these wells and recommend solutions to this impact.

3. Advise the recommended minimum yield required for single family residences.

4. Advise the minimum size of lots in each area of future development with respect to groundwater availability.

5. Advise what phasing, if any, is required for future growth. One aspect of this may be that growth in certain locations may be permitted, while growth in other locations may be delayed, depending upon the impact the permitted growth will have on the aquifer(s).

6. Recommend the necessary future test well construction and pumping, if this is required, to support the report findings.

7. Advise the well water quality that can be expected as well as quantity.

8. Evaluate the possible impact of septic tank system effluent from proposed developments on the groundwater supply.

9. The following meetings shall be considered to be part of this study:

(a) Two meetings to review the draft report
(b) One public meeting.

10. The following are the number of copies of the reports that are considered to be part of this study:

(a) Fifteen copies of the draft report.
(b) Thirty copies of the final report.

11. The draft report shall be submitted to the Region for review six weeks after authorization has been given to start the study. The final report will be completed three weeks after comments to the draft report have been forwarded to the consultant.

A

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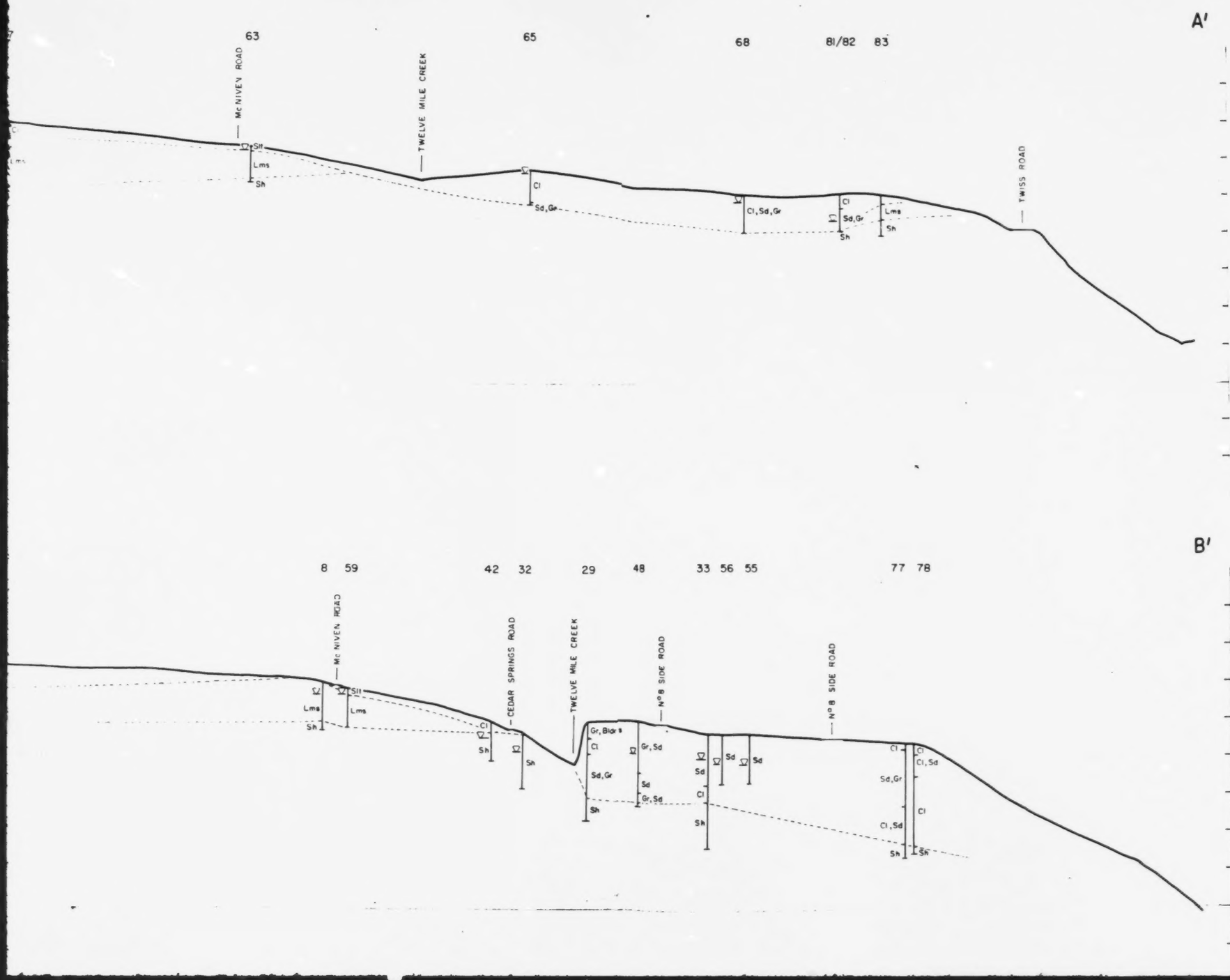


## LEGEND

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| Cl | CLAY |
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| Sd | SAND |
| Gr | GRAVEL |
| Stns | STONES |
| Bldrs | BOULDERS |
| Lms | LIMESTONE (DOLOMITE) |
| Sh | SHALE |
| ▽ | WATER LEVEL |
| ..... | GEOLOGIC CONTACT (INFERRED) |

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- GROUNDWATER DIVIDE
- DIRECTION OF GROUNDWATER MOVEMENT
- REPRESENTATIVE DRILLED WELL
- EXISTING COMMUNITY

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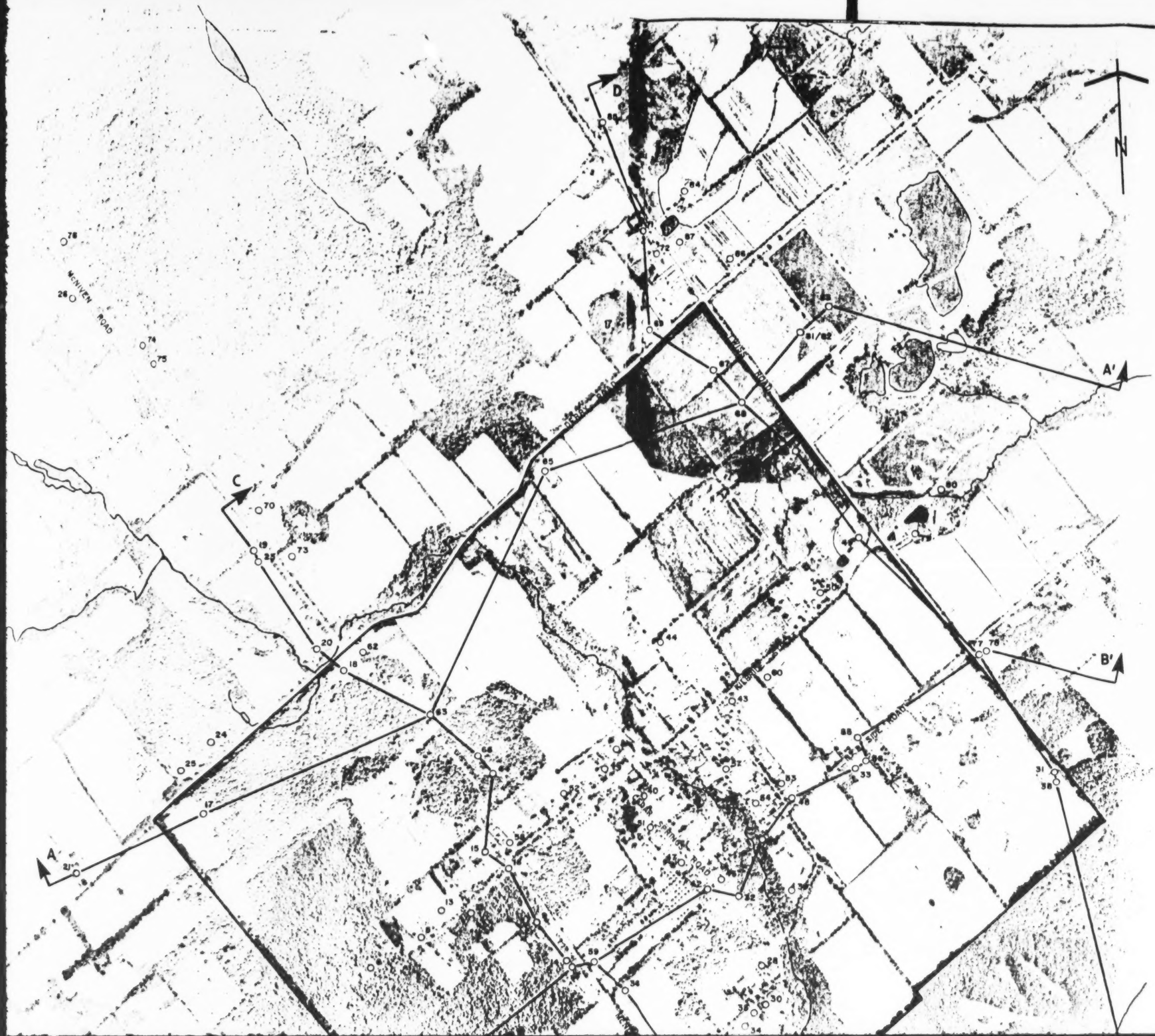
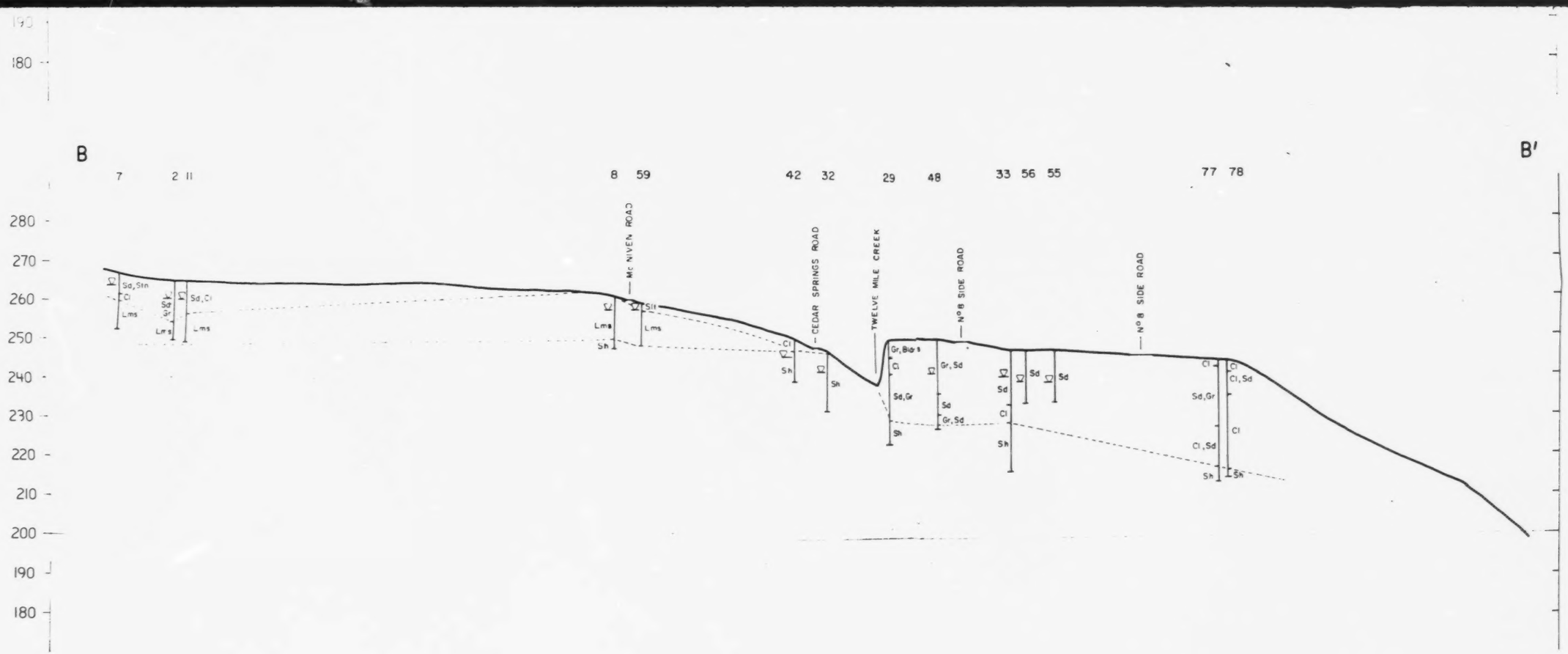



LEGEND

STUDY AREA

REPRESENTATIVE DRILLED WELL

LINE OF GEOLOGIC SECTION

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VERTICAL — 1:1,000 (IN **METRES** ABOVE SEA LEVEL)

REGIONAL MUNICIPA
KILBRIDE HYDROGEOL

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HYDROLOGY
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| | |
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| Job N° | 883 |
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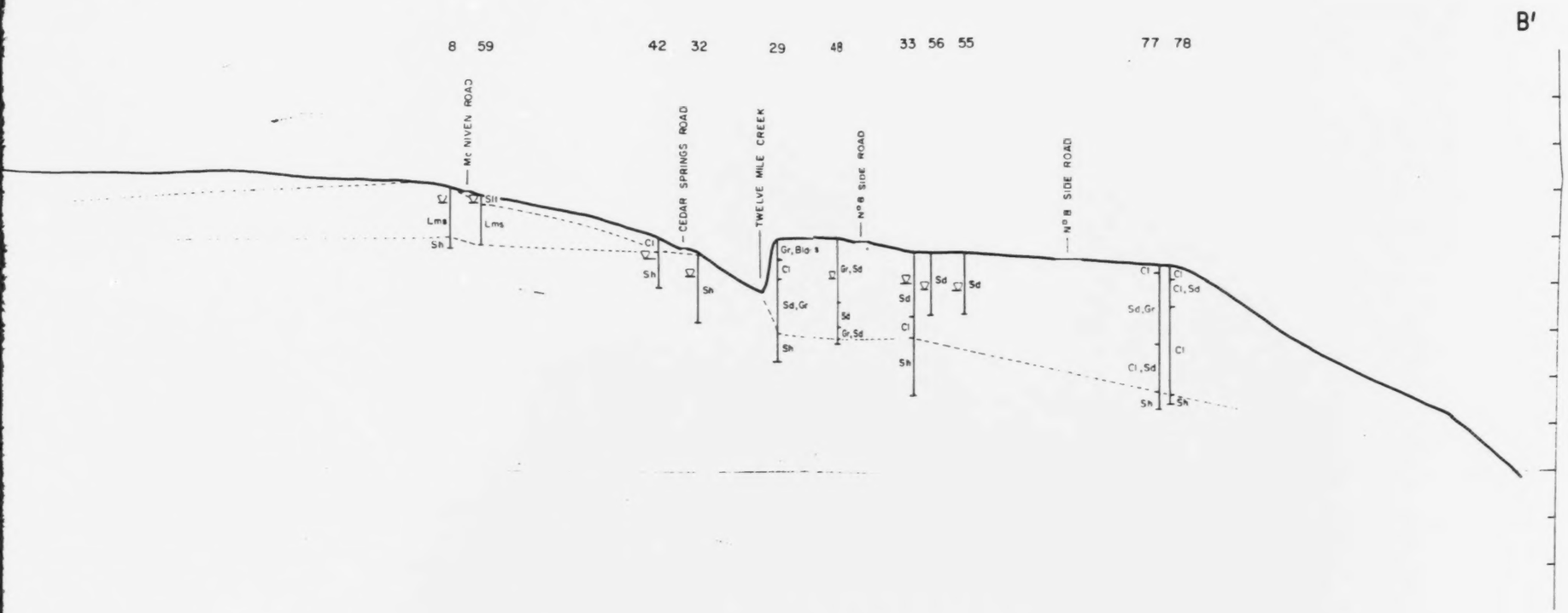
GEOLOGIC CONTACT ( INFERRED )




**SCALE:** HORIZONTAL — 1:10,000
VERTICAL — 1:1,000 (IN METRES ABOVE SEA LEVEL)

REGIONAL MUNICIPALITY OF HALTON
KILBRIDE HYDROGEOLOGIC INVESTIGATION

# GEOLOGIC SECTIONS A – A', B – B'

HYDROLOGY CONSULTANTS LIMITED
CONSULTING ENGINEERS AND GEOLOGISTS

| | | | |
|---|---|---|---|
| Job NO | 8839 | Scale | As Shown |
| Drwn. by | JFS | Date | OCTOBER, 1980 |
| Appr. by | LGB | FIGURE 1 | |
| Revised | | | |

REGIONAL MUNICIPALITY
KILBRIDE HYDROGEOLOGIC

HYDROGEOLOGIC A

HYDROLOGY CO
CONSULTING ENGINEERS A

| | |
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| Job Nº | 8839 |
| Drwn. by | JFS |
| Appr. by | LGB |
| Revised | |

EXISTING COMMUNITY

REGIONAL MUNICIPALITY OF HALTON
KILBRIDE HYDROGEOLOGIC INVESTIGATION

# HYDROGEOLOGIC AREAS

HYDROLOGY CONSULTANTS LIMITED
CONSULTING ENGINEERS AND GEOLOGISTS

| | | | |
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| Job Nº | 8839 | Scale | 1:10,000 |
| Drwn. by | JFS | Date | OCTOBER , 1980 |
| Appr. by | LGB | | MAP 2 |
| Revised | | | |

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REGIONAL MUNICIPALITY
KILBRIDE HYDROGEOLOGIC
LOCATIONS OF REPRES
WELLS AND GEOLOGIC
HYDROLOGY CO
CONSULTING ENGINEERS A
Job No 8839
Drwn. by JFS
Appr. by LGB
Revised

REGIONAL MUNICIPALITY OF HALTON
KILBRIDE HYDROGEOLOGIC INVESTIGATION

# LOCATIONS OF REPRESENTATIVE DRILLED WELLS AND GEOLOGIC SECTIONS

HYDROLOGY CONSULTANTS LIMITED
CONSULTING ENGINEERS AND GEOLOGISTS

| | | | |
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| Job No | 8839 | Scale | 1:10,000 |
| Drwn. by | JFS | Date | OCTOBER , 1980 |
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STUDY AREA

REPRESENTATIVE DRILLED WELL

1 — Area with extensive residential development or contributing recharge to the hamlet. Additional development may impact on the quality and/or quantity of existing well sources.

2 — Area underlain by sediments or bedrock with good infiltration capacity and capable of sustaining residential development on 0.8-hectare lots.

3 — Area underlain by sediments of low to moderate infiltration capacity and capable of sustaining residential development on 1.2-hectare lots.

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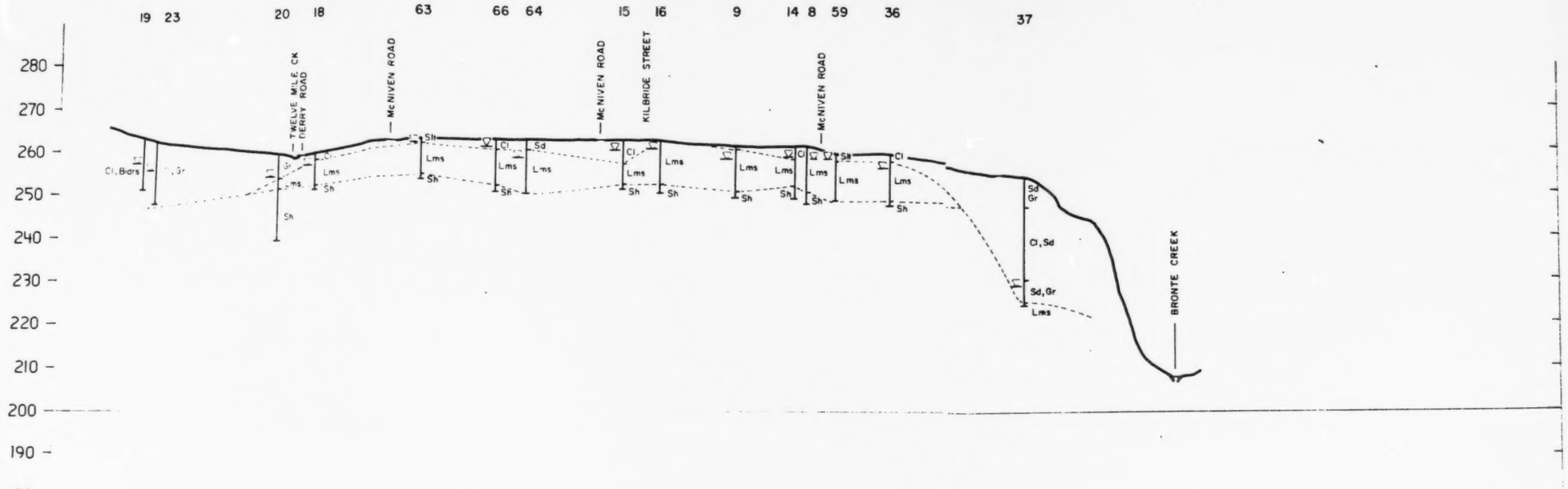
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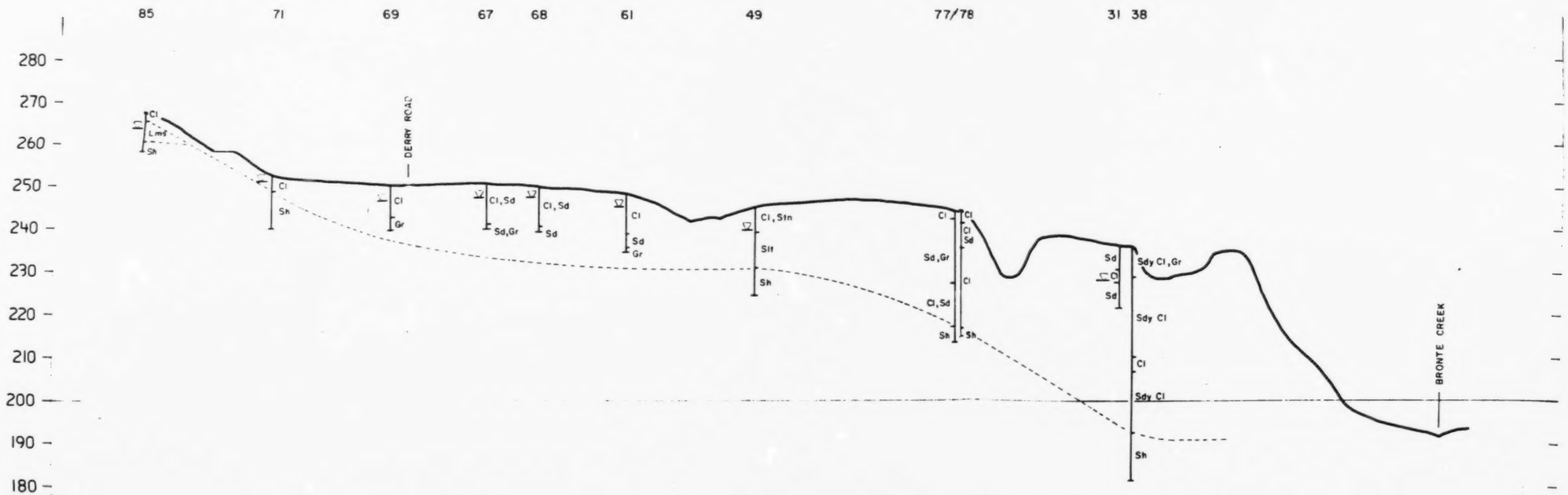
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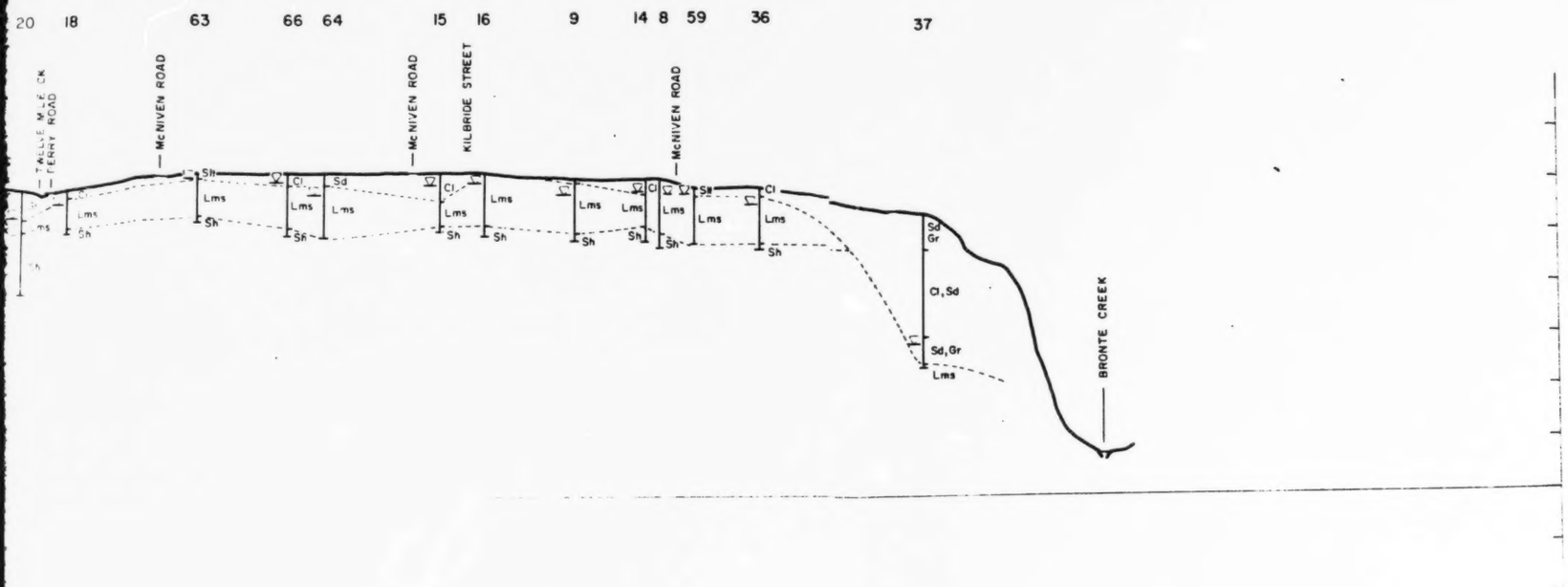
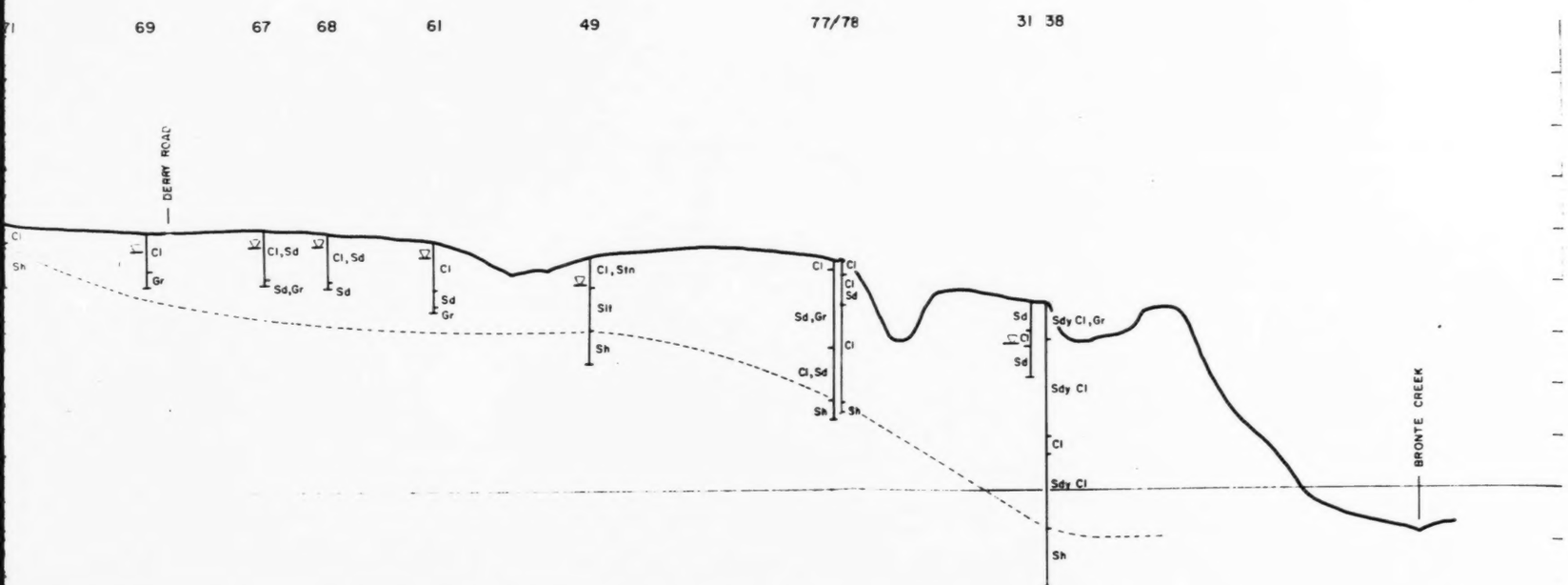



D'




## LEGEND

| | |
|---|---|
| Cl | CLAY |
| Slt | SILT |
| Sd | SAND |
| Gr | GRAVEL |
| Stns | STONES |
| Bldrs | BOULDERS |
| Lms | LIMESTONE (DOLOMITE) |
| Sh | SHALE |
| ▽ | WATER LEVEL |
| ---------- | GEOLOGIC CONTACT (INFERRED |

1 ...ment. Additi... ...pact on the qua... existing well sou...

2 ...eas underlain by... ...with good infiltra... ...capable of sustain... ...ment on 0.8-hectar...

3 ...eas underlain by... ...moderate infiltrat... ...capable of sustain... ...development on 1.2...

REGIONAL MUNICIPALITY
KILBRIDE HYDROGEOLOGIC

DEVELOPMENT AREA

HYDROLOGY CONS
CONSULTING ENGINEERS AND

| | |
|---|---|
| Job Nº | 8839 |
| Drwn. by | JFS |
| Appr. by | LGB |
| Revised | |

2 — ...s underlain by sediments or bedrock ...ving moderate infiltration capacity and ...capable of sustaining residential development on 0.2-hectare lots.

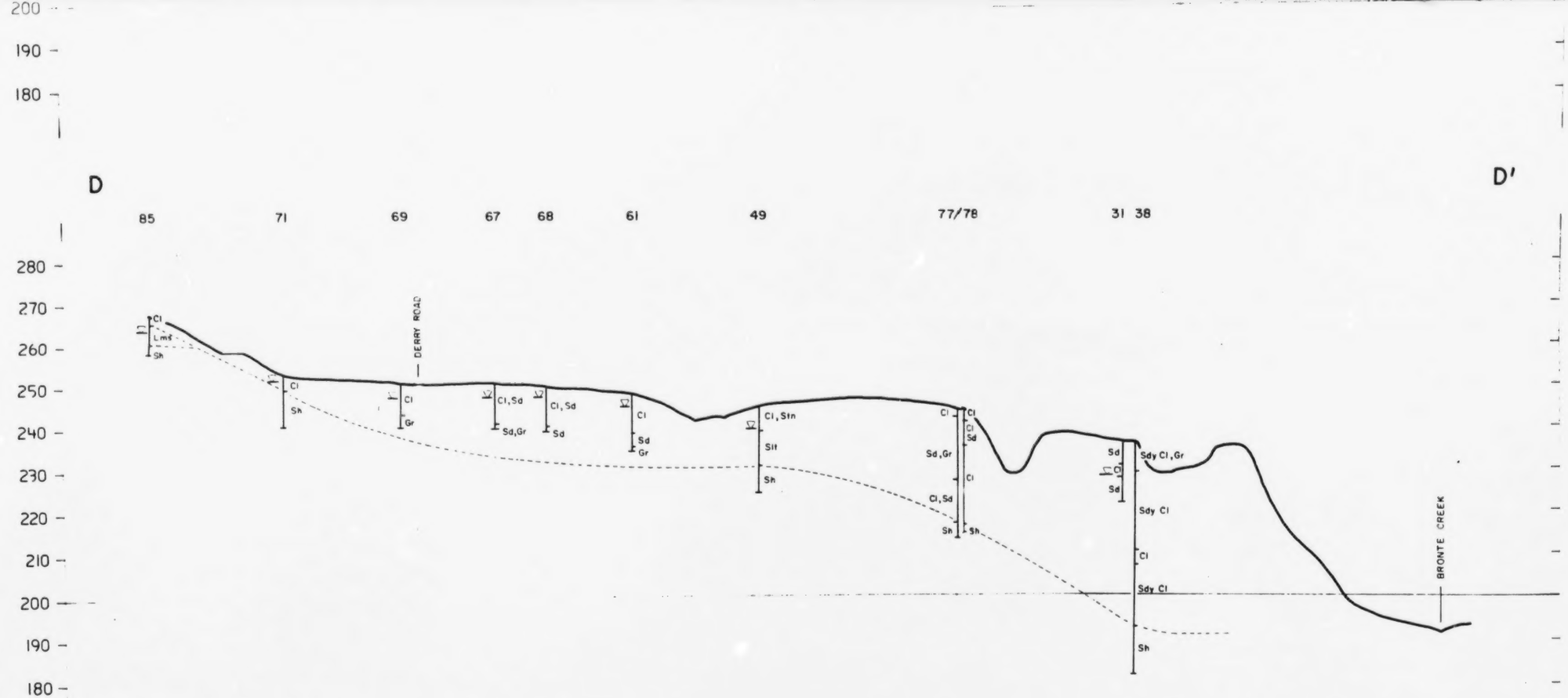
3 — ...s underlain by sediments of low to ...moderate infiltration capacity and ...capable of sustaining residential development on 1.2-hectare lots.

REGIONAL MUNICIPALITY OF HALTON
KILBRIDE HYDROGEOLOGIC INVESTIGATION

# DEVELOPMENT AREAS

HYDROLOGY CONSULTANTS LIMITED
CONSULTING ENGINEERS AND GEOLOGISTS

| | | | |
|---|---|---|---|
| Job No | 8839 | Scale | 1:10,000 |
| Drwn. by | JFS | Date | OCTOBER, 1980 |
| Appr. by | LGB | | MAP 3 |
| Revised | | | |




**SCALE :** HORIZONTAL — 1 : 10,000
VERTICAL — 1 : 1,000 (IN **METRES** ABOVE SEA LEVEL)

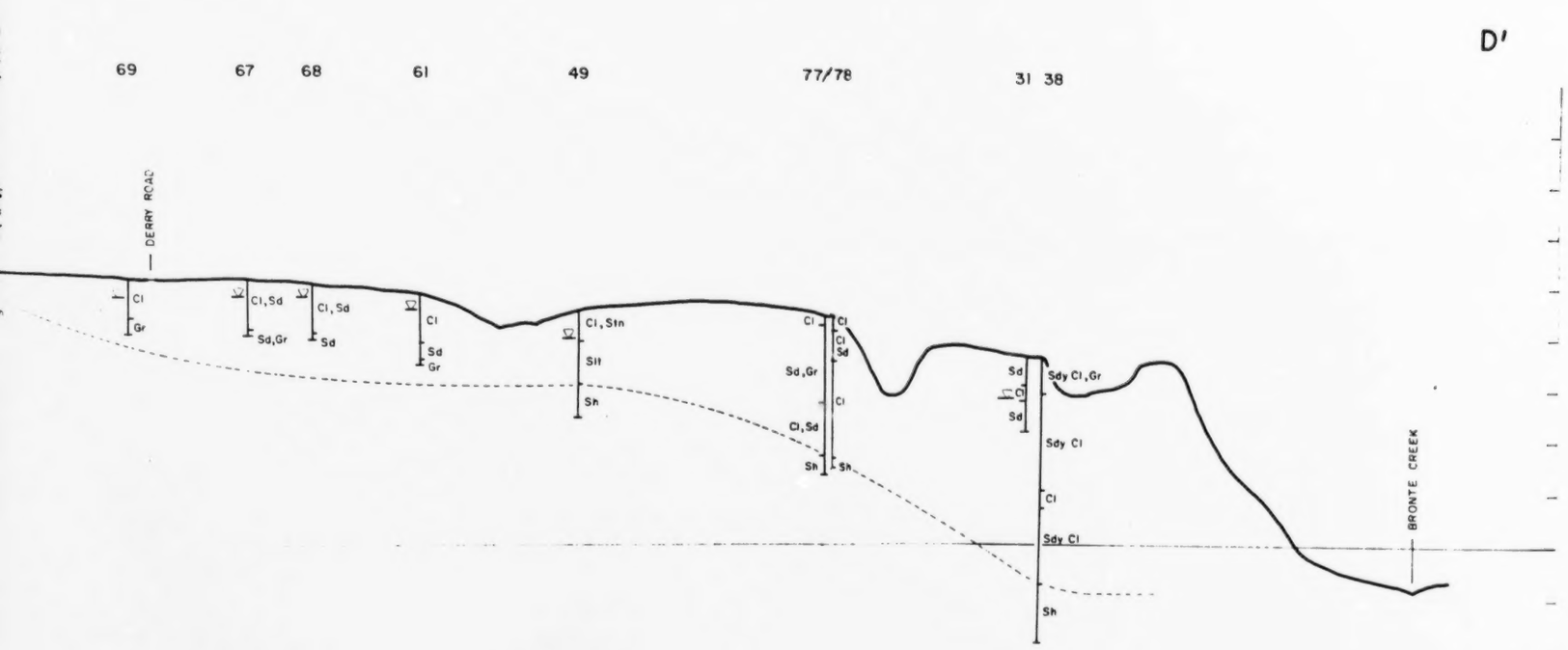
REGIONAL
KILBRIDE HY

GEOLOGIC

HYDR
CONSULT

| | |
|---|---|
| Job No | |
| Drwn. by | |
| Appr. by | |
| Revised | |

| | |
|---|---|
| Cl | CLAY |
| Gr | GRAVEL |
| Sd | SAND |
| Slt | SILT |
| Stn | STONES |
| Bld | BOULDERS |
| Lms | LIMESTONE (DOLOMITE) |
| Sh | SHALE |
| ▽ | WATER LEVEL |
| ---------- | GEOLOGIC CONTACT (INFERRED |




SCALE: HORIZONTAL — 1:10,000
VERTICAL — 1:1,000 (IN METRES ABOVE SEA LEVEL)

REGIONAL MUNICIPALITY OF HALTON
KILBRIDE HYDROGEOLOGIC INVESTIGATION

# GEOLOGIC SECTIONS C – C', D – D'

HYDROLOGY CONSULTANTS LIMITED
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| | | | |
|---|---|---|---|
| Job NO | 8839 | Scale | As Shown |
| Drwn. by | JFS | Date | OCTOBER, 1980 |
| Appr. by | LGB | FIGURE 2 | |
| Revised | | | |